THE MODERN BAKER CONFECTIONER & CATERER

THE MODERN BAKER

CONFECTIONER AND CATERER

INTERIOR OF HIGH-CLASS CONFECTIONER'S SHOP

THE MODERN BAKER CONFECTIONER AND CATERER

A PRACTICAL AND SCIENTIFIC WORK
FOR THE BAKING AND ALLIED TRADES

EDITED BY

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WITH CONTRIBUTIONS FROM LEADING
SPECIALISTS AND TRADE EXPERTS

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EDITORIAL NOTE

This work differs from any other hitherto offered to the trades it is intended to serve, in its scope and in the manner of treatment. The ideal aimed at was to make it a faithful record of all that is known and all that is necessary in connection with the businesses of baking, confectionery, and catering, with the qualification that the latter is considered only so far as it may be a branch or department of the business of a baker and confectioner. The technical matter, it is hoped, will be helpful to workers in all departments, while the business hints may serve the purposes of those intending to start in business, and of those already firmly established who may desire to alter their methods. In a work of this magnitude there is plenty of room for faults, and I am conscious of much that might be improved; but it has been entirely gratifying to note that as each volume has been issued the subscribers have been pleased with the work, and have generously indicated their satisfaction and assisted with their criticism.

The staff of specialist contributors is probably as strong as any possible at the moment. Each is an expert in his own department, and can speak with authority as one with extensive practical experience of the matter with which he deals. To give continuity and similarity of treatment to the whole work the contributions of the different writers have not been isolated, but their share may be broadly indicated. Mr. H. W. Lee, who has had a very extensive English and continental experience, and is teacher of confectionery at the National School of Bakery and Confectionery, London, has contributed the greater part of the matter on Confectionery, Sweets, &c. The chapter on Marzipan Work and the coloured plates illustrating it are contributed by Mr. Edwin Schur of Putney, who is acknowledged on all hands to be one of our cleverest confectioners and the most accomplished decorative artist in sugar and marzipan work in the kingdom. The chapters on Figure and Art Piping (with coloured plate) and the Restaurant Kitchen are the work of Mr. F. Russell of Liverpool. The former subject Mr. Russell has made particularly his own. Most of the cookery recipes and notes on the restaurant were contributed by Mr. Charles Aldridge, who has had an extensive English, foreign, and colonial experience in hotel, restaurant, and club kitchens. The late Mr. Graham, of St. John's Wood, London, contributed the greater part of the notes on outside catering. The chapters on Dutch and some other Continental breads were prepared by Mr. Pieter W. Jedeloo, who is the technical manager of one of the largest bread, cake, and rusk factories in Holland. Mr. Edwin J. Watkins, F.C.S., who is a practical analyst and works chemist to a leading London firm, and has specialized in bakery chemistry, has contributed important matter on analysis, essences, fats, sugars, malts, &c. Mr.

G. Strother Wright, F.C.A., F.S.A.A., who has a specially extensive experience as a bakery auditor, is responsible for the chapter dealing with a system of book-keeping for bakers, confectioners, &c. There are several tables and forms and a partial system of accounts in the chapters relating to a baking factory business which are not part of Mr. Wright's system, but the principles underlying these do not materially differ from those enunciated by Mr. Wright. The matter on flour markets and notes on some Continental breads are the work of Mr. Arthur Barker, one of the leading market experts in the United Kingdom. The contributions of the editor mostly relate to breadmaking.

The arrangement of the different sections of the work has been adopted with a view to keeping allied subjects together, although it has been occasionally impossible to avoid a break between parts that seem to have a close connection. The copious index and the tables of contents will, however, obviate any inconvenience that might arise from this, and will make the work easily available as a book of reference.

I have to acknowledge with sincere thanks the valuable assistance I have received from many leading men in the trade, amongst whom I might mention Mr. A. L. Johnston, Wimbledon; Mr. C. Paul, Streatham; Mr. R. Kirkland, Liverpool; Mr. T. Stevens, Cardiff; and Mr. H. Matthews, Plymouth. For the loan of blocks and for special information I should like to acknowledge indebtedness to Joseph Baker & Sons, Ltd., London; Werner, Pfleiderer, & Perkins, Ltd., Peterborough; Sumerling & Co., London; Richmond Gas Stove and Meter Co., Ltd., Warrington; Cox & Son, Birmingham; C. Hawkins, Ltd., Worcester; Thomas Melvin & Sons, Ltd., Glasgow; T. H. Tonge, Pendleton, Manchester; Belhaven Engineering and Motors, Ltd., Wishaw; Frederick Sage & Co., Ltd., London; National Cash Register Co., Ltd., London; Baird & Tatlock (London), Ltd.; A. Gallenkamp & Co., Ltd., London; Mr. Dempsey, Belfast; and others.

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THE MODERN BAKER

CONFECTIONER AND CATERER

CHAPTER I

HISTORICAL INTRODUCTION: BREAD IN ANCIENT TIMES

Discovery of Leaven.

The word "bread" occurs in many places in the Old Testament, but it does not always signify exactly the same thing. In the early part of its history bread was probably nothing more than bannocks of bruised grain; in the latter part it referred to bread fermented with leaven. The discovery of the leaven process was probably made by accident, and made comparatively early, because in Eastern countries a mixture of meal and water only would start to ferment if forgotten for one day, and the difference in the bread baked from dough in this condition and that from dough newly made could not long escape observation.

All the evidence scattered through literature of the processes of bread-making as first practised, indicates that it was a purely domestic industry, conducted, both as to preparing the grain and making the bread, by the females of the households. In the larger households, such as the establishments of kings, the specialization of the baker's duties would be a necessity. This we find was the case in the courts of the Pharaohs. The fact that the baker who obtained such unenviable notoriety in the time of Joseph (*Genesis*, xl) was the chief baker indicates that there must have been others. By the time the Israelites had settled in Egypt the leaven process had evidently become universal, since only the hurry of the departure from Egypt prevented their bread being leavened as usual—"and the people took their dough before it was leavened, their kneading-troughs being bound up in their clothes upon their shoulders" (*Exodus*, xii. 34). The troughs, from their size, were evidently only domestic utensils.

Hosea and the Baker.

Amongst a people so clever as the Jews there is little doubt that baking became afterwards developed as a trade, and the leaven process was thoroughly understood. In *Hosea* vii there is evidence that the baker had ceased to be a mere domestic, and the same evidence points to the fact that baking as carried on at that time was in its essential features quite like the baking as practised but a few years ago, with long processes and the use of small quantities of barm or leaven.

In one of the exhortations of the prophet the people are compared to "an oven heated by the baker, who ceaseth from raising after he hath kneaded the dough, until it be leavened. . . . They have made ready their heart like an oven, whiles they lie in wait: their baker sleepeth all the night; in the morning it burneth as a flaming fire. . . . Ephraim is a cake not turned." With our present knowledge it is easy to discern in this simile the kind of bakers they had in Samaria about 750 B.C. The prophet Hosea seems to have had an intimate knowledge, amongst other things, of the baker's methods and his ways.

The ruins of Pompeii and other buried cities have furnished evidence of the kind of bakeries existing when these cities were in their glory. These bakeries were in some cases part of the domestic establishments of the rich, but there were also public bakeries, in which the bread of the poorer people was brought to be baked, or from which they could obtain ready-baked supplies. In Rome's strenuous times baking of bread was a domestic affair, the work of women; but after the war with Perseus, the last king of Macedonia (168 B.C.), some bakers were brought from Macedonia, probably as captives, but they were evidently admitted as freemen, and from then the industry started as a distinct profession.

Pompeian Bakeries.

Along with the Macedonian bakers a number of freedmen were put to work as assistants, and the whole craft was incorporated in one body called a college—*Collegium Pistorum*—from which neither the bakers nor their children were allowed to withdraw. It should be pointed out that such colleges were little more than trade guilds common to all developed trades. They held their effects in common, and could not dispose of any part of them. Each bakehouse had a patron, who was its superintendent, and the patrons elected one of their number each year, who superintended all the rest, and had the care of the college. The position of the brotherhood was high in affairs of state, for one of their representatives was elected to a seat in the Senate.

Bakers' College or Guild at Rome.

The bakers in Rome at this period were held in high repute, and were endowed with extensive privileges. They were the only craftsmen who were freemen of the city, all other trades being conducted by slaves. Each baker had his shop or bakehouse, and they were distributed into fourteen regions of the city. They were excused from guardianships and other offices, which might divert their attention from their employment. To preserve honour and integrity amongst the members, they were expressly prohibited from having any connection with comedians and gladiators, and from attending the exhibitions at the amphitheatre, so that they might not be contaminated with the vices of the ordinary populace. It is too much to suppose that all these regulations as to the personal conduct of the Roman bakers were made with no purpose but the moral elevation of the trade; their purpose was probably rather to keep the bakers, if possible, from being used as agents in the plots and counterplots which permeated the whole life of Rome at that period. When the poison

Social Status of Roman Bakers.

Probable Meaning of Strict Regulations.

cup was so handy as a means of removing inconvenient friends, and when lives were so little regarded, it was highly important that bakers should be kept out of the poison plots; otherwise bread, especially of the fancy sorts, might have become a better and safer vehicle for conveying poison than wine, and no man would be safe. Instead of bakers being highly honoured by the strict regulations, these must have been extremely irksome. Bakers were really made a sort of social eunuchs, that they might be free from suspicion of tampering with the bread, particularly with that of the rich and powerful.

It may be interesting to quote from Pliny's *Natural History* as to the time bakers were first established in Rome, the materials they used, the methods they followed, and the kinds of bread they made. This author says:—"There were no bakers in Rome till the war with King Perseus, more than 500 years after the building of this city. The ancient Romans used to make their own bread, it being an occupation which belonged to the women, as we see the case in many nations even at the present day (about 70 A.D.). We have the fact well ascertained that the cooks in those days were in the habit of making the bread for persons of affluence, while the name of *pistor* was only given to the person who pounded the spelt. In those times they had no cooks in the number of their slaves, but used to hire them for the occasion from the market.

"The Gauls were the first to employ the bolter that is made of horse-hair, while the people of Spain made their sieves and meal-dressers of flax, and the Egyptians of papyrus and rushes."

The First Bolters.

The account given of the special preparation of leaven or yeast cakes is particularly interesting:—"Millet is more particularly employed in making leaven, and if kneaded with must (from wine tubs) it will keep a whole year. The same is done, too, with the wheat bran of the best quality. It is kneaded with white must three days old, and then dried in the sun, after which it is made into small cakes. When required for making bread, these cakes are first soaked in water, and then boiled with the finest spelt flour, after which the whole is mixed up with the meal: and it is generally thought that this is the best method of making bread. The Greeks have established the rule, that for the modius (a little over a peck of 14 lb.) of meal, 8 oz. of leaven is enough. These kinds of loaves (yeast cakes), however, can only be made at the time of vintage; but there is another leaven, which may be prepared with barley and water at any time it may happen to be required. It is first made up into cakes of 2 lb. in weight, and these are then baked on a hot hearth, or else in an earthen dish upon hot ashes and charcoal, being left till they turn of a reddish-brown. When this is done the cakes are shut close in a vessel until they turn quite sour. When wanted for leaven they are steeped in water first."

Yeast Cakes and their Use.

"When barley bread used to be made it was leavened with the meal of the fitch, or else the chickling-vetch, the proportion being 2 lb. of leaven to two and a half modii (2½ pk.) of barley meal. At the present day, however,

the leaven is prepared from the meal that is used for making the bread. For this purpose some of the meal is kneaded before adding the salt, and is then boiled to the consistence of porridge, and left till it begins to turn sour. In most cases, however, they do not warm it at all, but only make use of a little of the dough that has been kept from the day before."

Roman Barley Bread.

"It is very evident", continues this author, "that the principle which causes the dough to rise is of an acid nature, and it is equally evident that those persons who are dieted on fermented bread are stronger in body. Among the ancients, too, it was generally thought that the heavier wheat was the more wholesome."

Pliny's Theory of Fermentation.

Flour or wheat blending seems to have been considered of much importance amongst Roman bakers, and they, like the moderns, had a keen appreciation of a high yield. Those who think the craze for white bread is quite a modern weakness will note that colour was one of the main tests for quality in wheat and in bread in Pliny's time. Thus: "The wheat of Cyprus is swarthy, and produces a dark bread, for which reason it is generally mixed with the white wheat of Alexandria, the mixture yielding 25 lb. of bread to the modius of grain".

Wheat Yield and Blending.

"To knead the meal with sea-water, as is mostly done in the maritime districts, for the purpose of saving the salt, is extremely pernicious. There is nothing, in fact, which will more readily predispose the human body to disease."

Saving Salt.

"In Gaul and Spain, where they make a drink (beer) by steeping corn, . . . they employ the foam which thickens on the surface as a leaven; hence it is that the bread in these countries is lighter than that made elsewhere." This was not the only distinction possessed by Gallic bread, for it seems that it was made there from a kind of spelt to which was given the name of "brace". "It has a grain of remarkable whiteness, and yields nearly 4 lb. more bread to the modius than any other kind of spelt."

Brewers' Yeast used in Gaul and Spain.

Bread was made from millet, which, we are told, swells much in the baking, and weighs so heavy that "a modius of millet yields 60 lb. weight of bread". A kind of wheat grown in Thrace is stated to have ripened forty days after sowing, to weigh very heavy, and to produce no bran. The heaviness of wheat and the bread produce were considered of much importance. On these matters Pliny writes:—"We find it as a rule, universally established by nature, that in every kind of commissariat bread that is made, the bread exceeds the weight of the grain by one-third; and in the same way, it is generally considered, the best kind of wheat is that which in kneading will absorb one congius (slightly under 6 pt.) of water to the modius of wheat. There are several kinds of wheat which, when used by themselves, give an additional weight to this: the Balearis wheat, for instance, which to a modius of grain yields 35 lb. weight of bread. Others, again, will only give this additional

Forty Days' Wheat Without Bran.

Rule for Water Absorption and Yield.

weight by being mixed with other kinds. The Cyprian wheat and the Alexandrian, for example, which, if used by themselves, yield no more than 20 lb. to the modius. The wheat of Thebais, in Egypt, yields 25 lb. weight of bread."

Hard and Soft Wheats.

In Rome they had many sorts of bread, the names of which, like the names of our own sorts, were names of association rather than of description. It is interesting to have this point definitely settled. "Some kinds," writes this author, "we find, receive their names from the dishes with which they are eaten—the 'oyster bread', for instance; others, again, for their peculiar delicacy—the 'artolaganus' or 'cake bread', for example; and others from the expedition with which they are prepared, such as the 'speusticus' or 'hurry' bread. Others receive their name from the peculiar method of baking them, such as 'oven bread', 'tin bread', and 'mould bread'. It is not very long since we had a bread introdueed from Parthia, known as 'water bread' from a method of kneading it, of drawing out the dough by the aid of water, a process which renders it remarkably light and full of holes like a sponge. Some call this 'Parthian Bread'. The excellence of the finest kinds of bread depends principally on the goodness of the wheat and the fineness of the bolter. Some persons knead the dough with eggs or milk, and butter even has been employed for the purpose by nations that have had leisure to cultivate the arts of peace, and to give their attention to the art of making pastry."

Varieties of Roman Bread.

Influence of Peace on Bread-making.

"Picenum still maintains its ancient reputation for making the bread which it was the first to invent, Alica being the grain employed. The flour is kept in soak for nine days, and is kneaded on the tenth, with raisin juice, in the shape of long rolls, after which it is baked in an oven in earthen pots till they break. This bread, however, is never eaten till it has been well soaked, which is mostly done in milk mixed with honey."

It is more than probable that the technical details given by this author are incorrect—some of them certainly are; but they are near enough the truth to indicate that a good many of the methods still in use were practised by the bakers of Rome about the beginning of the first century. Brewers' yeast, leaven, yeast cakes, are still in common use in different countries. The "water bread" of Parthia seems to have been identical with that now made in Portugal and, in a lesser degree, in Holland, and parts of Germany and France. The flour barms of Scotland, made from scalded flour, had their forerunners in the bakeries of Rome.

In the degenerate days of Rome the bakers must have been busy as well as powerful; for, according to Gibbon, in the fifth century, "for the convenience of the lazy plebeians, the monthly distributions of corn were converted into a daily allowance of bread; a great number of ovens were constructed and maintained at the public expense; and at the appointed hour, each citizen, who was furnished with a ticket, ascended the flight of steps which had been assigned to his peculiar quarter or division, and received, either as a gift or at a very

Public Bakeries in Rome.

low price, a loaf of bread of the weight of three pounds for the use of his family." Scarcity of corn, and therefore of bread, was one of the constant troubles and dangers of Roman government.

Ovid mentions a peculiar purpose to which on one occasion the Romans put loaves of bread. When Rome was besieged by the Gauls, the soldiers, stationed on the Tarpeian Hill threw down loaves of bread, to indicate that they had abundance of provisions, whereas they were really on the point of surrendering through famine. As this expedient was supposed to be adopted on the advice of Jupiter, the latter was given the surname of *Pistor*, signifying *baker*.

Jupiter Pistor.

There is plenty of evidence scattered through classical literature that bread was treated with more than ordinary respect, and its merits were not beneath the notice of the highest. In the *Meditations* of Marcus Aurelius there is the following interesting and subtle reference to a point about bread that even now is worthy of notice: "It is worth while to observe that the least thing that happens naturally to things natural has something in itself that is pleasing and delightful. Thus, for example, there are cracks and little breaks on the surface of a loaf, which, though never intended by the baker, have a sort of agreeableness in them which invites the appetite." We still value the "cracks and little breaks", and take pains to ensure that if they do not appear naturally they shall be made to appear by artificial means.

Marcus Aurelius on Bread.

Our greatest fund of knowledge with regard to the bread and bakers of ancient times is found in a work entitled *Deipnosophistæ* by the Egyptian grammarian and philosopher Athenæus, who flourished early in the third century A.D. He says that the best bakers were from Phœnicia or Lydia, and the best makers of bread from Cappadocia. He quotes from a lost poem by Archestratus, who writes:—

Bakers with Ancient Reputations.

"Take care and keep a Lydian in thy house,
Or an all-wise Phœnician, who shall know
Your inmost thoughts, and each day shall devise
New forms to please your mind and do your bidding".

Archestratus on Good Bakers.

Evidently the ancients were much like the moderns, and appreciated from time to time "something new" in the bread line.

Athenæus gives a list of the kinds of bread common in his time and of those mentioned in the works of previous writers and poets. There were leavened and unleavened loaves; those made from the best wheaten flour; loaves made of groats; some made of remnants, and these the author says were more digestible than loaves made of the best flour. "Remnants" was evidently a kind of coarse flour or meal left after the fine flour had been sifted from the ground wheatmeal, and it is interesting to note that thus early the idea was prevalent that the offal is the more nutritious part of the berry. There were loaves made of rye, and some made of acorns, and some of millet. The groats referred to were oaten groats, for our author says "groats are not made of barley".

Varieties of Ancient Bread.

A kind of loaf called "Ipnites", or the oven loaf, received its name from the peculiar way in which it was baked and washed over. Evidently these were crusty loaves, and may have been glazed. Timocles is quoted as writing:—

Early Crusty Loaves.

> "And seeing there a tray before me full
> Of smoking oven loaves, I took and ate them".

Another sort, called the "hearth loaf", was evidently enticing enough also to invoke the praise of the ancient author, who wrote:—

> "I took the hot hearth loaves, how could I help it?
> And dipped them in sweet sauce, and then I ate them".

Loaves called "Collabi" were made from young wheat:

> "Here I come, bearing in my hands the offspring
> Of three months' wheat, hot, doughy Collabi,
> Mixed with the milk of the grass-feeding cow".

New Wheat Loaves.

There was bread mixed with cheese, called "Tyron". Some coarse sort was made large and named "Cilicians":

> "And he went forth and bought some loaves; not nice
> Clean rolls, but dirty, large Cilicians".

One sort called "Nastus", which was a large loaf of leavened bread, was evidently a pleasant-smelling loaf, of which Nicostratus says:—

> "Such was the size, O master, of the Nastus,
> A large white loaf. It was so deep; its top
> Rose like a tower quite above its basket;
> Its smell, when that the top was lifted up,
> Rose up, a fragrance not unmixed with honey,
> Most grateful to our nostrils, still being hot."

Tall Loaves with Tops.

From this description the Nastus was evidently a loaf made in two parts, like a modern cottage loaf, proved in a basket and baked in a pan; and the reference to honey is evidently more an attempt to indicate an odour by comparing it with one well known, than a proof that honey was one of the ingredients, since it is described as large and white.

Archestratus, quoted above, seems to have been quite an authority on bread and bakers:

> "First, my dear Moschus, will I celebrate
> The bounteous gifts of Ceres the fair-haired,
> And cherish these my sayings in thy heart.
> Take these most excellent things, the well-made cake
> Of fruitful barley, in fair Lesbos grown,
> On the circumfluous hill of Eresus;
> Whiter than driven snow, if it be true
> That these are loaves such as the gods do eat,
> Which Mercury their steward buys for them.

Praising White Bread.

Good is the bread in seven-gated Thebes,
In Thasos, and in many other cities,
But all compared with these would seem but husks
And worthless refuse. Be you sure of this.
Seek, too, the round Thessalian roll, the which
A maid's fair hand has kneaded, which the natives
Crimmatias call, though others Chondrinus.
Nor let the Tegean son of finest flour,
The fine Encryphias, be all unpraised.
Athens, Minerva's famous city, sends
The best of loaves to market, food for men;
There is besides Erythra, known for grapes,
Nor less for a white loaf in shapely pan,
Carefully moulded, white and beautiful,
A tempting dish for hungry guests at supper."

The appreciation of good bread was a point of culture among the ancients, and between the various cities and towns the keenest rivalry seems to have existed as to which produced the best bread, and the same rivalry in the matter of quality existed among the individual bakers. Athens, among the cities, claimed the premier position for good bread, and the name of its greatest baker, Thearion, has been handed down through the ages in the writings of more than one author. Plato speaks of him as pre-eminently one who skilfully provides for the body, while Athens and Thearion are thus praised by Antiphanes:—

A famous Athenian Baker.

" For how could any man of noble birth
Ever come forth from this luxurious house,
Seeing these fair-complexioned wheaten loaves
Filling the oven in such quick succession,
And seeing them devise fresh forms from moulds,
The work of Attic hands, well trained by wise
Thearion, to honour holy festivals ".

Thearion's Bakery and Bread.

And Aristophanes says in reference to the same baker:—

"I come now, having left the baker's shop,
The seat of good Thearion's pains and ovens ".

But Athens was not allowed the palm for good bread without dispute. Lynceus sings the praises of the Rhodian Rolls: "While they" (the Athenians) " talk a great deal about their bread which is to be got in the market, the Rhodians, at the beginning and middle of dinner, put loaves on the table which are not at all inferior to them; but when they are given over eating and are satisfied, then they introduce a most agreeable dish which is called the hearth loaf, the best of all loaves; which is made of sweet things, and compounded so as to be very soft; and it is made up with such an admirable harmony of all the ingredients as to have a most excellent effect; so that often a man who is drunk becomes sober again, and in the same way a man who has just eaten is made hungry again by eating of it."

Rhodian Rolls.

Cyprus had a reputation for good bread. Eubulus says:—

> " 'T is a hard thing, beholding Cyprian loaves,
> To ride by carelessly, for like a magnet
> They do attract the hungry passengers ".

Cyprian Bread.

There were loaves for occasions and for purposes. Aristophanes mentions a kind called " Cribanites ", or the pan loaf. A woman is introduced selling bread, who complains that her loaves have been taken from her by those who have got rid of the effects of their old age:

Pan Loaves.

> " My hot loaves, my son,
> My nice pan loaves,
> So white, so hot ".

A loaf of very large size, called "Achæinas", was made by the women who celebrated the festival of Thesmophoria, and was sold in the streets by men, whose cry was: " Eat a large Achæinas, full of fat". Some Sicilian bread made of sycamine was credited with the property of making those who ate it lose their hair and become bald. Another sort is said to have had " every possible good quality, for it gives a felicitous and wholesome juice, and is good for the stomach, and is digestible and agrees with everyone, for it never clogs the bowels, and never relaxes them too much ".

Bread with Fat.

There seems to have been a great variety of materials from which bread was made, and the following contemporaneous estimate of their relative nutritive properties, quoted by Athenæus, is interesting:— " Loaves made of wheat are by far more nutritious, and by far more digestible than those made of barley, and are in every respect superior to them; and the next best are those which are made of similago; and next to those come the loaves made of sifted flour; and next to them those which are made of unsifted meal ".

Materials used in Bread.

Another authority quoted by the same writer says: " Loaves made of similago are superior to those made of groats, and next those made of groats, then those made of sifted flour. But the rolls made of bran give a much less wholesome juice . . . All bread is more digestible when eaten hot than eaten cold, and affords a pleasanter and more wholesome juice; nevertheless hot bread is apt to cause flatulence, though it is not the less digestible for that; while cold bread is filling and indigestible. But bread which is very stale and cold is less nutritious, and is apt to cause constipation of the bowels, and affords a very unpleasant juice."

From these details of the digestive properties of bread it would seem that the loaves were really loaves, and not cakes or biscuits; that is, they contained a considerable proportion of soft crumb.

In Athenæus several curious and interesting technical details of manufacture are given. Thus of one kind of loaf he says: " If you make it with hard leaven, it will be bright and nice, so that it may be eaten dry; but if it be made with a looser leaven, it will be

Notes on Kinds of Fermentation.

light but not bright. But the loaf which is made in a pan, and that which is made in an oven, require a softer kind of leaven. And among the Greeks there is a kind of bread which is called tender, being made up with a little milk and oil, and a fair quantity of salt; and one must make the dough for this bread loose. This kind of loaf is called the Cappadocian, since tender bread is made in the greatest quantity in Cappadocia. . . . [This] is the best bread made in Syria, because it can be eaten hot, and it is like a flower. But there is another loaf . . . made like a mushroom, and the kneading trough is plastered with poppies smeared over the bottom of it on which the dough is placed, and by this expedient it is prevented from sticking to the trough while the leaven is mixed in. But when it is put in the oven, then some groats are spread under on a tile, and then the bread is put on it, and it gets a most beautiful colour like cheese which has been smoked. There is also a kind of bread called Strepticias, which is made up with a little milk, and pepper and a little oil is added, and sometimes suet is substituted. And a little wine and pepper and milk, and a little oil or sometimes suet is employed in making the cake called Artolaganum. But for making the cakes called Capuridia tracta you mix the same ingredients that you do for bread, and the difference is in the baking." It is difficult to understand the use of poppies to prevent dough sticking to the trough, but it was probably a decoction of poppies that was used, as water alone is still used on the Continent for this purpose. The cakes mentioned in the last paragraph were evidently dough cakes, and this description shows that a clear distinction between cake and bread was recognized, and that the varieties of loaves mentioned are not merely names of different sorts of cake, as has been suggested. There are many references to cake, generally cheese cakes, and the ingredients used in their manufacture seem to have been milk, honey, cheese, eggs, and oil, with pepper and aniseed principally, as spices.

Fancy Breads.

One great point about bread and bakers in the ancient civilizations was the respect in which they were held. Their standards of excellence were the same as ours: "white and tempting" were the usual and poetic terms in which bread was spoken of. Bread was dedicated to, and placed in the temple of the god Saturn for everyone to eat that pleased. In one of the cities of Bœotia statues were erected to Megalartus, the god or goddess of Great Bread. Probably the first author on bread-making, at least the first of whom there is any record, was Chrysippus of Tyana, a city of Cappadocia, who wrote a Treatise on the Art of Bread-making about 240 B.C.

The God of Great Bread.

First Author on Bread-making.

CHAPTER II

HISTORICAL INTRODUCTION: ASSIZE AND BREAD LAWS

The practice of government in the early history of England was to regulate the price of nearly everything. There were assize laws to fix the prices of meat, of clothing, of bread, and of ale. Only the latter two remained to within what may be called modern times, the Bread Assize being in fact abolished as late as 1822.

First Assize Laws.

In the early English period there were constantly recurring periods of famine, due to excessive rains, droughts, or frosts, and those in authority, knowing that famine was an almost certain precursor of rebellion on the part of poor people, were willing to use all the powers at their command to prevent the price of bread becoming too high. The earliest authentic mention of laws regulating the price of bread relates to those passed in the reign of King John (1202), although, as mentioned by Adam Smith, in reviving the law for the assize of bread and ale, Henry III refers to it in the preamble as a law which had been made in the time of his progenitors, "sometime kings of England"; and Smith concludes that the law was therefore first passed in the reign of Henry II, and that it may even have been as old as the Conquest. Not only did the law fix the price of bread, but it also strictly allocated that price between cost of material and an allowance for several necessary charges to the baker.

Bakers' Charges.

Thus in 1266 the assize law allowed the baker only 12 pence for each quarter of wheat he made into bread, allocated as follows:—For three servants, $4\frac{1}{2}d.$; for two lads, $1d.$; for salt, $\frac{1}{2}d.$; for yeast, $\frac{1}{2}d.$; for candle, $\frac{1}{4}d.$; for wood, $2d.$; for his boutell (bolting), $\frac{1}{2}d.$ The records do not indicate how the other $2\frac{3}{4}d.$ are made up, but the baker was also allowed two loaves and the bran for his advantage, and these were evidently valued at that amount. The allowances seem very small, but this is owing to the much greater value of money in those early days.

Wages in 1266.

According to Fleetwood, the wages of master carpenters about this time were $2d.$ per day, whilst ordinary carpenters obtained only $1\frac{1}{2}d.$ As bakers' wages always have been somewhat lower than those of carpenters, owing to the outdoor work of the latter and their dependence on the weather, it seems that the rate fixed for bakers was not unduly low.

Charges in 1298.

In the reign of Edward I the allowance to the master baker was raised to 13 pence, made up as follows:—For growt and furning, $3d.$; for wood, $3d.$; for the journeyman, $3\frac{1}{2}d.$; for the two pages, $1\frac{1}{2}d.$; for salt, $\frac{1}{2}d.$; for yeast, $\frac{1}{2}d.$; for candles, $\frac{1}{2}d.$; for his ty dogge, $\frac{1}{2}d.$ The growt and furning had evidently something to do with the grinding of the wheat, and as there is nothing in this list relating to bolting, as in some of the others, it was probably included with the cost of grinding.

According to the law made in the 51st year of the reign of Henry III, the kinds of bread allowed to be made were halfpenny and penny cocket,

made of the second-priced wheat, halfpenny and penny wheaten, and penny household. The relative values of the several kinds of bread seem to have been that three halfpenny-worths of white bread should always weigh one pennyworth of wheaten bread, and one pennyworth of household bread should weigh two pennyworths of white bread. The wheaten bread was therefore two-thirds the value of the finest, and the household half the value of the finest.

Kinds of Bread in Henry III's Reign.

In fixing the price of bread, the standard by which the jury of mayor and aldermen was guided was in its way quite scientific, and had all the appearance of fairness. Trials were made by bakers of the yield of bread from the flour of several sorts of wheat then in the market, and the yield obtained from such trials was the basis of calculation for fixing the price at which the baker must sell. These trials were only made at long intervals, and evidently with great care and precision. Joseph Powell, who was clerk of the markets in London in 1592, thus describes two such trials:—" First there was a trial made in the year of our Lord 1311, which is now 303 years past [the description was written in 1614], of 3 quarters of wheat, viz.: 1 quarter of best wheat, 1 quarter of second wheat, and 1 quarter of third wheat, and these three quarters were made into divers and several sorts of bread, as it appeareth by record in the Guild Hall of London. They which made the same trials were sworn for the true doing thereof before the Lord Mayor of London for the time being." The next trial was in the eighth year of Henry VIII (1517), and therefore 206 years after the other. This was made, " by the commandment of the King's Counsells, of one quarter of wheat, and it was made 2 parts into wheaten bread, 1 part into white bread, and the 4th part into household bread. This was in the time of Sir Wm. Butler, then Lord Mayor of London, and it is entered into the Guild Hall in the paper journal. The which sorts and kinds of bread have thus continued unto this day [1614], and that the bakers at this time do bake and retail more wheaten bread than ever before they have done."

Early Assize Trials.

By an Act of 1495, " Every baker should be allowed 2*s.* for all manner of charges in baking a quarter of wheat, over and above the second price of wheat in the market by which he ought to size his bread, which 2*s.* was allowed in this manner. When wheat was 12*s.* the quarter, the baker should bake after 14*s.* the quarter, and at 14*s.* he should have 16*s.*"

Bakers' Allowance in 1495.

The 2*s.* per quarter of wheat was allocated as follows:—Furnace and wood, 6*d.*; the miller, 4*d.*; two journeymen and two pages, 5*d.*; salt, yeast, candles, and sack bands, 2*d.*; himself, his house, his wife, his horse, his cat, and his dog, 7*d.*; and the bran to his advantage. In 1592 (34 Eliz.) the baker's allowance was raised to 6*s.* 10*d.*, allocated as follows:—Fuel, 6*d.*; two journeymen and two apprentices, 1*s.* 8*d.*; yeast, 1*s.*; salt and candles, 4*d.*; himself, his wife, children, and house, 2*s.*; the miller's toll, 1*s.* 4*d.* This allowance was, however, reduced again to 6*s.*, and to 4*s.* in the case of those who made only the coarser kinds

Bakers' Allowance in 1592.

of bread, and it so remained off and on till about 1636, although, while the practice of settling the price of bread seems to have been rigidly adhered to, this was done without any definite understanding as to the clear allowance to the baker, and the allowances made intermittently varied a good deal. On this account the Joseph Powell already alluded to refers specifically to the omission of the baker's allowance in the general regulations, and, as clerk of the markets, makes fresh trials of the yield from wheat "taken in divers counties in England, not only in the view of mine own eyes, but also in the presence of expert skilful men learned in the law, having great and deep knowledge in the assaying of bread"; and the result of these trials was that the bakers in cities, boroughs, and corporate towns, where three sorts of bread, viz. white, wheaten, and household, were made and sold, were allowed 6*s.* per quarter of wheat above the second price of wheat in the market, while "all inhabiting bakers, out of cities, boroughs, and towns, or within those where but two of the sorts of bread, viz. white and household, are usually made", were allowed only 4*s.* per quarter of wheat baked into bread. This discrimination against country districts was based on the principle that they had less charges for rent and taxes than those in the towns. Another form in which an effort was made to balance the burdens of the town and country bakers was to force those who took their bread for sale into the town markets, to weigh their loaves heavier than those of the town bakers for the same price. At one time the bread supply of London almost wholly depended on that brought in by the bakers of Stratford (in Essex) in "long carts". These carts evidently came in a long procession, and mention is made of one occasion of scarcity in 1527 when the mobs attacked the bread carts on their way from Stratford to London at Mile End, and they had to be rescued by the lord mayor and sheriffs. The Stratford bakers sold their bread along Cheapside and elsewhere. Their loaves were heavier than those of the London bakers, who, according to Herbert, in his *History of the Livery Companies*, settled in Bread Street ward, that they might be near the market of St. Michael-le-Querne. Stow says that the Stratford bakers left serving the City about 1568, and in his own time Bread Street was no longer the haunt of bread-sellers, but was "wholly inhabited by rich merchants".

Fresh Trials of Wheat by Experts.

Outentownies or Country Bakers' Allowances.

The Stratford Bakers and their Long Carts.

Bread Riots at Mile End.

The bakers were not rich, either as individuals or as a corporation, and they seem to have been rather oppressed by the authorities through the assize laws. Several instances are recorded in which they reached a state of rebellion, or at least of strong protest. About 1648 there was a petition presented by the Bakers' Company against a bill brought before Parliament setting the Assize of Bread. By this bill the lord mayor and aldermen were to be given power to allow the baker such profits as they thought fit; but the protest lugubriously continues, "which of late they have not allowed them any". Protest was made against a stipulation, evidently new, that the baker's

Bakers' Protest against New Bill, 1648.

name should be marked on every loaf. This was stated to be impossible, the plea being "That bread is now made much lighter and finer than heretofore, and the dough is made so weak that no impression, or at least not so many distinct impressions or marks can lie or continue, . . . the heat of the oven swells the dough to that degree that the several impressions run into one another". The bakers protested also against a stipulation proposed in this new bill, that power to fix the price of bread, and to search and weigh it, should be given to any one alderman or justice, contending that under the old law of Henry III they were entitled to the verdict of a jury of "12 lawful men" for this purpose; but they further contended that by a charter granted in the eleventh year of Elizabeth the power to "govern and correct all freemen and foreigners using the Trade of Bakers", was given to the master and wardens of the Bakers' Company, and that therefore the transfer of this power to magistrates and justices was a direct infringement of their just rights. In this appeal it is definitely stated that the bakers "for 40 years past, as settled by the mayor and court of aldermen", had been allowed 12*s.* per quarter of wheat "for their charges, pains, and livelihoods"; there had evidently, therefore, been a considerable increase in the allowance made shortly after 1592, of which the definite allocation has been given. This allowance seems to have been altered very frequently, which fact may account in some degree for the sudden rise from 6*s.* to 12*s.* recorded above. In the eighth year of Anne (1710) the money allowance was fixed at 12*s.* per quarter of wheat. About this time the condition under which the trade was conducted seems to have altered, in the direction of bakers becoming buyers of flour and not of wheat, for the law stipulates that the "allowance" is given as so much per sack of flour instead of per quarter of wheat. In the time of George III this allowance was raised from 11*s.* 8*d.*, to which in the interval it had evidently fallen, to 14*s.* 1*d.* per sack of flour.

Soft Dough Bakers.

Charter of Bakers' Company.

Bakers' Allowance on Flour instead of Wheat.

In the fourteenth and fifteenth centuries it was not the price of bread only that was regulated by statute, but the kinds of bread and the materials from which they should be made were also governed by enactments. People who were poor and common were only allowed to eat poor and common bread. At one time brewers were strong competitors with bakers for wheat brought to market, and Parliament had frequently to interfere and decree that other grain than wheat should be used for beer-making. No better idea of the trade restrictions which prevailed during this time can be given than by quoting at some length from Powell's direction, which was in a way an official document, he being, as already noticed, clerk of the markets and therefore the official principally concerned with the administration of the regulations. Stripped of their legal phraseology, and in modern spelling, the instructions were as follows:—"First, that no manner of person or persons shall keep a common bakehouse in cities (bakers' shops were not yet an institution) and corporate towns, but such

Bakers and Sumptuary Laws.

Only Bakers Allowed to Trade.

persons as have been apprenticed into the same mystery, or brought up therein for a space of seven years, or be otherwise skilled in the good making and true sizing of all sorts of bread, and shall put his own proper mark and seal upon all sorts of his man's bread." (The expression "man's bread" was used to distinguish it from "horse bread", which was also sold.)

"Item.—That no bakers or other person do make, bake, utter, and sell any kinds and sorts of bread, but such which the statutes and ancient ordinances of the realm do allow them. That is to say, they may bake and sell simnell bread, wastel, white, wheaten, household, and horse bread, and none other kinds."

Lawful Bread.

"Item.—They may make and bake farthing white bread, halfpenny white, penny white; halfpenny wheaten, penny wheaten, penny horse bread, and twopenny horse bread, and none of greater size, upon pain of forfeiture unto poor people of such great bread as they or any of them shall make to sell of greater size (the time of Christmas always excepted)."

Prices of Ancient Bread.

"Item.—They shall not make and sell to any inholder or vitaler either in man's bread or in horse's bread (which shall retail the same), but only thirteen pennyworth for twelvepence, without any poundage or other advantage."

Wholesale Prices.

"Item.—They shall size and deliver into vitalers and inholders horse bread, but 3 loaves for a penny and XIII pennyworth for XII pence as aforesaid, every one of the same 3 loaves weighing the full weight of a penny white loaf, whether wheat is good cheap or dear."

Horse Bread.

"Item.—That no bakers, &c., that at any time or times hereafter make, utter, or sell by retail, within or without their houses, unto any of the Queen's [Eliz.] subjects any spice cakes, buns, biscuits, or other spice bread (being bread out of size and not by law allowed), except it be at burials, or on Friday before Easter, or at Christmas, upon pain of forfeiture of all such spiced bread to the poor."

No Spice or Fancy Bread.

"Item.—Whereas there are in cities and corporate towns common bakers using the mystery of baking, there are within the same towns the foreign bakers that come into the market with their breads to be sold, who shall only bring with them such kinds and sorts of bread as the laws and ordinances do allow to be made and sold as aforesaid: they shall keep and observe this order in the weight of their breads, because the foreigners do not bear and pay within the cities and towns such Scot and Lot as the bakers within the same towns do. 1st. The foreigners' halfpenny white loaves shall weigh half an ounce more to every loaf than the halfpenny loaves of the bakers of the same towns do, their penny loaves shall weigh an ounce more, their halfpenny wheaten 1 oz. more, their penny wheaten 2 oz. more, their penny household 2 oz. more, and their twopenny household 4 oz. more."

Foreign Bakers' Prices.

These regulations were applicable not to London only, but to all cities and corporate towns in England. Although the laws in Scotland at this time differed in many respects from the English, the town councils exercised

a sharp control over traders. There is still in the possession of the Incorporation of Bakers of Glasgow the original Act of Council granted in favour of the bakers in 1556, which is as follows:—

Glasgow Bakers' Rights.

"Item.—It is statute by ye provost, baillies, and counsell, that ye baxteris of Glasgow, sall in all times cumming, haif three mercat dayes in ye oulk for bringing of their breid to the Crocc (Cross). They are to say Moninday Weddensday and Fryday. And at (that) nayne outtentowneris (strangers) breid be sauled at ye said mercat croce but upon ye samyn three days. And it sall not be lesum to nayne traweller that brings breid to the mercat to sell ye samyn to nayne outtentowneris man in laides (loads), crieles (baskets), nor half crieles jumgit ye gedder (in heaps) quhile the inhabitants of the towne be first servit, and XII houris struken, and that na man of man sell the breid that is brocht to the towne bot the bringar of the same allanerlie (alone), and that na traweller bring breid to ye towne to sell but IIIId breid and twa-penny breid, and that this be observit in all poyntis under the pane of escheting of the breid to ye seller that sellis outtentowneris breid befoir XII houris, and VIIId to the trone (the weighing machine at the Cross). And that the Dekin of the baxteris under ye bailies serk (search), seek, and cause ye samyn to be observit.

(Signed) ANDW. HOGAN."

According to another edict of the Town Council about the same period, which allowed "unfreemen" to sell their wares in the High Street between 8 and 2 o'clock, "tappers of linnen and woolen goods" were allowed to stand till the evening, "but unfreemen who sell white bread (were) to keep the hours appointed" (finish at XII houris).

From this Act of Council it would seem that so far as the Glasgow and West of Scotland bakers were concerned, the kinds of bread made were already settled by custom as two-pound and one-pound loaves. This is confirmed by a copy of the assize regulation set in September 30th, 1560. "And ordainit, by ye provost, baillies and hail counsell, yat ye four penny laif (supposed to be Scots money) was thretty-twa ounces, and ye twa penny laif saxteen ounces, and yat the samyn be gud and sufficient stuffe"; and seemingly the only kind of bread allowed was that known at a later period as "assize bread", to distinguish it from another sort regulated in a different way and called "priced bread".

Glasgow Assize, 1560.

In Glasgow and other towns in Scotland the magistrates were allowed to exact from the bakers what were called "multer" or "ladle" dues for all flour baked within the Royalty, this tax amounting to one eighty-fourth part of the whole price. This was an ancient right of corporations, but it evidently needed periodic renewal, for in 1636, while King Charles I was at Newmarket, he granted a charter to the magistrates of Glasgow confirming their right to levy this tax. Their power did not, however, extend to bakers outside the bounds, and it was a matter of sore complaint to Glasgow bakers at the beginning of last century, that certain Bread Societies, on the co-operative principle, which had sprung up all over Scotland, and of which

one or two still exist, were free from "multer" dues because, as a rule, their bakehouses were outside the boundaries.

"Priced Bread."

Weights of Peck, Quartern, &c.

Under the assize laws from 1709 there were two distinct systems of selling bread allowed. The baker was not permitted to adopt both systems at once, but had to make a definite choice, by which he was afterwards bound, as to how he would sell his bread. There were two assize tables set, one for what was called "priced bread", the other for "assize bread". The quality or kind of bread was the same for both tables, but the manner of grading the several sizes, and the manner of allowing for alterations in the price were different. "Priced bread" was sold by denomination, as peck, half-peck, quarter-peck or quartern, and half-quarter-peck or half-quartern. The peck loaf weighed 17 lb. 6 oz., and the others in proportion, so that the quartern and half-quartern loaves, instead of weighing 4 lb. and 2 lb., as usually assumed, weighed respectively 4 lb. $5\frac{1}{2}$ oz. and 2 lb. $2\frac{3}{4}$ oz. In cases where half-quartern loaves were allowed to be made, they were to be half a farthing higher than the price given in the table, if it should happen that the table price would split the farthing. Whatever the market price of flour, "priced bread" remained always the *same weights* for the respective denominations, the *money price* only being altered to suit the market fluctuations in flour.

Assize Bread.

Advantages of Different Systems.

Present Methods of Selling Bread.

What was known as "assize bread" under the old laws, was distinguished from "priced bread" by the fact of its *weight* being changed in accordance with fluctuations in the wheat and flour markets. It was sold in "penny", "twopenny", "sixpenny", "twelvepenny", and "eighteenpenny" loaves. As the price of flour rose or fell, the weights of these several sizes could be altered in exactly the same proportion, by deducting or adding the number of drams or ounces of dough which would be the equivalent of the alteration in the market price of flour. By this method very small alterations in price of flour could be exactly allowed for, whereas, by the other system, as no alteration less than a farthing was possible, that being the smallest coin, therefore flour had to rise or fall in price by nearly 4*s*. before the alteration in the price of flour could be properly met by an alteration in the price of bread. It is curious and interesting to note that both systems still obtain in different countries and even in different parts of Great Britain. In London and the greater part of England the "priced bread" is the general rule, although recently the stress of competition has caused a return in some part to the assize system of altering weight rather than price. In Scotland and Ireland, although the "priced" system is adhered to in the case of the ordinary or household bread, the "assize" system is followed with regard to all so-called "fancy" breads, which form no inconsiderable part of the whole. In a good many districts in the North of England alterations are still made on the assize plan. In the Australian Colonies the system is rigidly followed of fixing the weights of loaves. In America, on the other hand, the more

mobile method of changing the weights and keeping the price constant has been adopted.

The main purpose of the Assize Laws was to cheapen bread, but they sometimes produced effects quite opposite. They did not give the satisfaction to the public which some who desire their renewal seem to think, and they created constant trouble with the bakers, who complained loudly of the unfair and sometimes corrupt manner in which they were administered. They were quite discredited before they were abolished, and in a great many cases they fell into disuse. Here is an extract from the records of the City of Glasgow, dated 29th January, 1801: "The magistrates and council, being satisfied for some time prior to setting the last assize, that it would be for the benefit of the community if no assize was set, and having considered the Act which was passed during the last session of Parliament known by the name of the 'Stale Bread Act', for regulating the assize and baking of wheaten bread, resolved to discontinue (at least for a time) the practice of fixing an assize of bread within the City and liberties thereof, and to leave it to the bakers to furnish bread to the inhabitants at such prices as they can afford; with the condition and declaration that the weights of the loaves furnished by the bakers shall be the same that they used to be when the assize of bread was fixed by the magistrates." The interesting point about this extract is its concern for fixed weights while allowing the baker full liberty as to price. Some twenty-one years later Parliament by an Act abolished the regulations fixing weights of loaves, and allowed the baker not only to fix the price of his bread but "to make it of any size and weight he thinks fit", the only reservation being that he must sell it by weight. The same Act stipulated that *for two years* after the passing of the Act bread must not, under a penalty, be sold by denomination, as peck, half-peck, quartern, and half-quartern. Evidently a two years' embargo was not sufficient to destroy the old denominations, as these names are still in common use as designations of loaves, even in preference to the names of the avoirdupois weights which the 1822 Act sought to introduce

Faults of Assize Laws.

Glasgow Council on Assize of Bread, 1801.

Abolition of Fixed Weights of Bread.

The "Stale Bread Act", passed in 1800 in consequence of a great scarcity, and referred to above,[1] stipulated that no baker should under a penalty sell his bread baken till it was 24 hours old, and the statute also insisted that only a small quantity of the bran was to be taken out of the grist, and that the ordinary loaves were to be made from the rough meal thus produced. The Act, however, was only administered for a few months.

Stale Bread Act, 1800.

It is interesting to note that an Act 31 George II (1791) fixed the amount of bread to be considered as the equivalent of a quarter of wheat at 365 lb., or 91¼ four-pound loaves, and the same Act stipulated that in fixing the price of bread magistrates were to

Yield of Flour, 1791.

[1] Wheat was 75*s*. and 80*s*. per boll, and the 2*d*. loaf at this date was weighed at 7½ oz. in dough, and the bakers stopped altogether making halfpenny rolls.

consider 20 peck loaves, or 80 quarterns, as the yield from a sack (280 lb.) of flour (about 87 four-pound loaves). Considering the soft nature of the home-grown wheat this estimate was probably not much under the actual yield.

Bakers' Punishments.

For offences against the Assize Laws bakers had to submit to fines, imprisonment, and other indignities, such as being fixed in the pillory or whipped at the cart's tail. As early as the reign of Edward I, 1298, there are records of fines inflicted on bakers for short-weight bread, and in 1310 a case is recorded in which a number of bakeresses who plied their trade at Stratford, and sent their bread to London in long carts, were had up for short weight, but as the bread was stale they were let off with a caution, but had to sell their stale halfpenny loaves at three for a penny. In 1327 an ingenious fraud was discovered as having been perpetrated by several bakers and bakeresses. The public at this time took their dough to the common bakehouse to bake, but the proprietors had a secret hole or holes made in the moulding boards, and as the "baking" was duly placed on the board one of the baker's family was secretly and successfully pinching piece after piece from the lumps "for the good of the establishment". The culprits being caught, the men were placed in the pillory with a quantity of dough hung round their necks, while the bakeresses were committed to Newgate. In later times fines from 6*d.* to as much as 5*s.* per ounce were inflicted on bakers who gave short weight, the fines going in some cases partly to the common informer and the overseers of the parish where the offence was committed. This allocation of fines is still part of the regulations under which bread is now sold, although it is doubtful if they are thus distributed. The Bakers' Company had power to levy fines for a good many faults on brethren in the trade. The baker's punishment seems in the past to have been nicely graduated to the quality of his offence. In Henry III's time if his farthing loaf was an ounce short he was fined, but if beyond that deficiency he was to be set in the pillory without the option of a fine, and if he offended often even in smaller degree the pillory was again his punishment. In the time of Edward I he could retain his freedom by paying a fine if his farthing loaf was only an ounce and a half short, but if more the pillory was his fate. By an order of The Privy Council made in the time of James I the "Clerk of the Market or the Mayor, Baliffe or the officers of cities, Corporate Townes and Liberties, or by the Master and Wardens of the Company of Bakers of London", were empowered to seize "all unlawful bread", and distribute it "to poore prisoners and other poore people". If anyone sold musty meal he was fined for the first offence, lost his meal for the second, was put in the pillory for the third, and drummed out of the town for the fourth. The same order of Council says, "it is a common practice with many, if not most, bakers, to slice or cut their stale white bread into sippets, and being well steeped and mollified in water, to intermix and knead the same together with their wheaten dow, to the great abuse and scandall of their Mysterie, and the wrong of his Majesties

Tricky Bakers, 1327.

subjects". The offending bakers are warned not to do this, but to make all their bread "all of new stuffe and pure". In a sermon published in 1631 the bakers and their servants are given very bad characters. They are called "Sophisticating Kneaders", and told they give short weight. They are accused among other things of deluding the searching magistrate by "supplying your shops with a few loaves of competent assize: while in your inward Roomes, or secretly behind, a numerous weight wanting batch lies ready to be uttered in his absence (while in your sleeve you laugh at him), unless the same before his coming bee sent forth to your confederate customers". The baker's men were accused of sticking copper coins into their light weight bread when they saw the bread examiner approaching.

The following interesting set of woodcuts is reproduced from the old work by John Powell, already referred to, and shows in a rough way the stages of bread manufacture then prevailing, which in some respects differed very little from methods common not so many years ago. The attachment of the couplet to each picture was quite in keeping with the spirit of the age, although it is to be feared that precept and practice were not always in perfect agreement:—

1 Selling or Measuring Wheat | 2 Sifting Meal | 3 Adding Salt to Sponge | 4 Weighing Pieces of Dough

He that giveth measure
God blesseth with treasure.

It maketh a poor man
To sell flour for bran.

Look well to thy season
With cunning and reason.

Be just with thy weights;
God plague false sleights.

5 Moulding Loaves | 6 Notching | 7 Docking Loaves | 8 Setting on Peel to place in Oven

God blesseth true labour
With plenty and favour.

Be still quick and kind,
Reward thou shalt find.

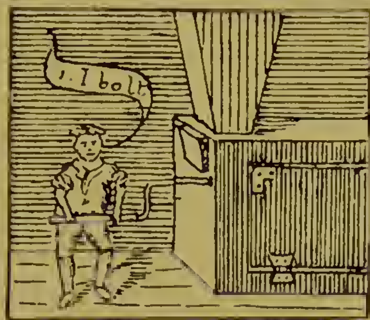
Prick not at thy pleasure,
But in true honest measure.

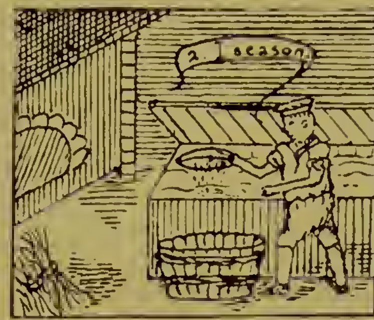
Be watchful and wise
In goodness to rise.

The second series of thirteen woodcuts is reproduced from a work called *Artachthos*, by John Penkethman, published originally in 1638 and republished in 1748.

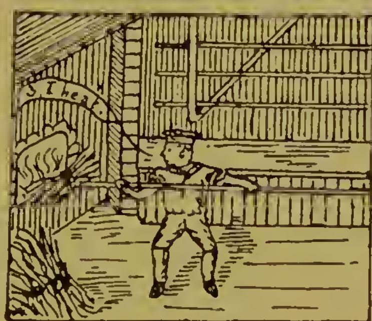
THE MYSTERIE AND TRADE OF BAKING

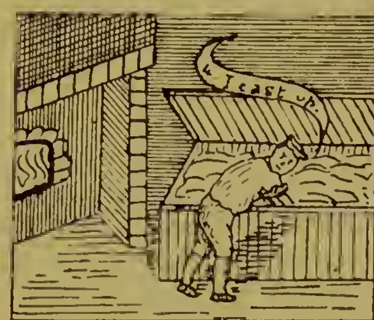
All services that to the Baker's Trade
Or mysterie belong, be here displaid,





Which my rude Arts in order shall recount,
And those in number to thirteen amount,
Being (how ere such Tradesmen used to coozen
In their scale measure) just a Baker's dozen.



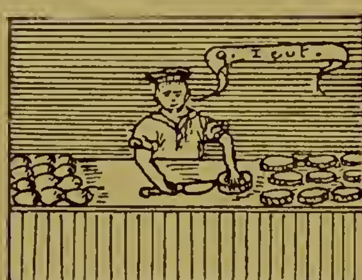


First [1] Boulting, [2] Seasoning, [3] Casting up, and [4] Braking,
[5] Breaking out dowe, next [6] Weighing, or weight making
(Which last is rarely seene), then some doe [7] Mould;
This [8] Cuts, that [9] Seales and Sets up, yet behold

The seasoner [10] Heating, or with Barin fires
Preparing the oven as the case requires;
One carrying up, the Heeter peeleth on
And playes the [11] Setter, who 's no sooner gone

But the hot mouth is [12] Stopt, so to remaine
Untill the setter [13] drawes all forth againe.

Thus bakers make and to perfection bring,
No less to serve the Beggar than the King,
All sorts of Bread, which being handled well,
All other food and Cates doth farre excell.



Let Butchers, Poultrers, Fishmongers contend
Each in his own trade, in what he can Defend,
Though Flesh, Fish, Whitemeat, all in fitting season,
Nourish the body, being used with reason,

Yet no man can deny (to end the strife)
Bread is worth all, being the staff of life.

With the exception of the "boulting", which is now an affair only of the miller, the "braking" (an operation now performed by rollers), and the "stopping" up of the oven after the batch is set, the processes of baking 300 years ago were evidently very much like those followed to-day. There has been a good deal of difference, however, in the terms used. We still speak of "setting", but not of "seasoning", which was evidently concerned

with adding the salt; for "casting up" we simply say kneading, for "sealing" we say bashing, and for "cutting" we use the term notching. The method of "casting dough", or breaking off pieces of dough with the hand on the edge of the table without the use of a knife or scraper, is still in use in some parts of the south of Ireland. But it is well within the memory of bakers not very old, that the processes here depicted in picture and verse might serve for an exact description of the operations in use when they were young. The writer has "braked" many a batch on a "brake" of the pattern shown in picture 5, only that it was fixed in a corner and was fan-shaped; while "stopping" all round the oven door or "back" with clay was the usual practice in all bakehouses with ovens of the old "pot" type. The number references in the text do not correspond throughout with the numbers on the cuts, but the mistakes are those of the seventeenth-century author.

CHAPTER III

HISTORICAL INTRODUCTION: BAKERS' GUILDS, COMPANIES, AND CORPORATIONS

Early Bakers' Guilds.

Bakers' Guilds were in existence as early as the time of Henry II, about 1155, but were, like the other trade guilds, only associations of traders bound together for the common benefit of the craft, their aim being to prevent those who had not qualified by apprenticeship and subsequent membership of the Company from trading within cities and corporate towns in which guilds were generally established. This power was not bestowed on the guilds at their birth, but, according to Norton, was acquired by the payment of large bribes to needy princes in return for the concession of monopoly of the particular trade to which the guild belonged. The Incorporation of the White Bread Bakers did not take place till 1307 in Edward III's reign, while the Brown Bread Bakers, who for a time had a separate existence, were granted their charter in 1621 by James I.

Special Powers in Elizabeth's Charter.

The White Bread Bakers had a new charter granted to them in 1498 by Henry VII, and had this confirmed to them, probably in each case for a handsome consideration, by all the other Tudor sovereigns. In the charter granted by Queen Elizabeth it appears the bakers first acquired powers to exercise full legal control over the trade, for when in the reign of James I it was proposed to pass a bill granting power to the mayor and aldermen to set the assize of bread and to make orders for its observance all on their own authority, the Bakers' Company protested that this power "is contrary and destructive to the Charter granted to the Corporation of the Bakers of London so long ago as the 11th year of the reign of the late Queen Eliza-

beth, by which the master and wardens of the said Company have authority to govern and correct all freemen and foreigners using the said trade within the City of London, and likewise have power to search and punish all offences concerning all kinds of bread within the City of London and suburbs and 2 miles round (Westminster excepted), and to take to the use of the Company all fines and amercements taxed on any offender, so that such Charter granted in consideration of charge and expense and payment of Scot and Lot will be rendered wholly unto the Company."

Stow mentions that in 1302, by an Act of Edward I the bakers of London were ordered to sell no bread in their shops or houses, but in the open market at Bread Street, and that the Bakers' Company should have "four hall motes (or courts) in the year, at four several terms, to determine of enormities belonging to the said Company". The nature of the service which the Bakers' and other companies were supposed to render to the trade and to the public may be gathered from the oath administered to the master and wardens, as follows:—"Ye shall swere that ye shall wele and treuly ov'see the Craft of Bakers whereof ye be chosen wardens for the year. And all the goode reules, ordyn'ces of the same craft that have been approved here be the court, and noon other, ye shall kepe and doo to be kept. And all the defautes that ye fynde in the same craft if don to the Chamberleyn of y' Citie for the tyme being ye shall wele and treuly p'ceute. Sparyng noo man for favour, ne grevyng noo p'sone for hate. Extorcion no wrong under colour of your office ye shall no doo, neither to noo thing that shall be agenst the state, peas, and people of our sovereign Lord the King, or to the Citie ye shall not concente, but for the time that ye shall be in office in all things that shall belongyng with the same craft after the lawes and franchoses of the seide citie will and lawfully ye shal have you. So help you God and all seyntes, &c." There is not much evidence to show how well the governors of the Company lived up to their obligations with regard to the "Citie", but they took good care of their own privileges, as witnessed by the number of protests, appeals, and petitions which were published by the Company.

Bakers Must Sell in Market.

Oath of Bakers' Company.

In early Plantagenet times the whole of the Trading Companies had to have their officers sworn in before the mayor and sheriffs of the City, and they were entitled or forced to send two of their liverymen to the Court of Common Hall, which is now only called together for the purpose of electing the Lord Mayor and sheriffs of the City, but at one time performed the much more important functions of finding money or men for war operations, or devising means for definite action, or for the protection of the City in times of crises.

Bakers' Company and City Corporation.

The general functions of the Company, or Companies, were to look strictly after the conduct of their own members. There were two Companies,—one, the White Bread Bakers, being much the more important, and the Brown Bread Bakers, who retained a separate existence, but

FORMER PRESIDENTS, NATIONAL ASSOCIATION OF MASTER BAKERS

FRANCIS TONSLEY, J.P., born in Northampton in 1856, was educated at the Grammar School there. He worked as an apprentice confectioner with his father, and, at the death of the latter took over the business at Sheep Street, afterwards, however, buying the oldest confectionery and pie business in Northampton. Mr. Tonsley was a Town Councillor for fifteen years, Mayor in 1898, Governor of the Technical Schools Hospital and Charities, and is now Alderman and Justice of Peace. He was President of the National Association in 1902 and 1903, and presided at the opening of the National Bakery School in 1902.

WILLIAM CALLARD was born in 1844 at Torquay, where his father was in business as a baker. He is a member of Devonshire County Council and Torquay Borough Council. Very early in the life of the National Association of Master Bakers he took a leading part in its business, and was elected President in 1905.

JOHN HICKS, born at Wavertree, Liverpool, in 1847, succeeded his father as a miller, corn-dealer, and baker in 1874. The whole trade in Liverpool have abounding faith in Mr. Hicks. He was made President of the National Association of Master Bakers in 1906.

E. W. BOWKETT was born at Ledbury, Herefordshire, in 1846. He started in business in Birmingham in 1868, and soon began to take an active part in public affairs, being elected to the Board of Guardians in 1876, and to the City Council in 1882. He was made Alderman in 1894 and Justice of the Peace in 1901. He was the "my friend Alderman Bowkett" of a famous speech on Tariff Reform, when Mr. Chamberlain exhibited two loaves supposed to represent the Free Trade and Tariff Reform sizes. Mr. Bowkett was President of the National Association of Master Bakers in 1904, and Chairman of the Executive for the succeeding three years. He died in 1907.

FRANCIS TONSLEY, J.P.
(Northampton)

WILLIAM CALLARD, C.C.
(Torquay)

JOHN HICKS
(Liverpool)

E. W. BOWKETT
(Birmingham)

FORMER PRESIDENTS, NATIONAL ASSOCIATION OF MASTER BAKERS

without incorporation, till 1622, but the latter seemed too weak to continue as a separate company, and seem to have again been joined with the White Bread Bakers some thirty-five years later.

Relative Importance of White and Brown Bread Bakers.

The powers of the Company, which were in the nature of a monopoly —so long, at least, as they were able to prevent others than bakers trading as such — came direct from the Crown, and their concession was really in payment of loans or gifts to the sovereign of the time, those kings or queens with the greatest needs being most willing to confer the largest powers. The Governing Charter of the Bakers' Company (2 James II) contains a power enabling the King, by order of the Privy-council, to amove the master, wardens, and assistants, or clerk of the Company. This was no new claim, for in 1507 (22 Henry VII) we find that the by-laws of the Company were rectified by the Lord Chancellor, the Lord Treasurer, and the Chief Justice of the King's Bench; and in 1622 (19 James I) the by-laws of the mystery of Brown Bread Bakers (who are united with the White Bread Bakers in the Governing Charter of James I) were settled under the hands of the Lord Keeper and the Chief Justice of the Court of King's Bench and Common Pleas.

Relation to the Crown.

Although the Bakers' Company dates its original charter and its existence some seven hundred years back, it has never been classed amongst the twelve great companies, which include the Tailors, Mercers, Grocers, &c. The Bakers' Company has been variously allocated a position, which, according to Stow, means only its place of precedence at the Lord Mayor's feasts, as the eighteenth company, but Stow assigns its position as the twenty-fifth company, although Herbert gives its position in 1509 as fifteenth. In any case, there is evidence amounting to proof that the authorities did not regard it as a great company, either in the matter of funds or power. In 1355, when the City Chamberlain required money from the various guilds, the Bakers' is not amongst the list of those who paid. In the reign of Edward III, when the Grocers, Brewers, Mercers, &c., sent six representatives each to the Common Council, the Bakers' Company only appointed two. In 1629 the White Bread Bakers were assessed in a City levy for £25, 16*s*., while the Brown Bread Bakers only paid £4, 6*s*. In 1665 the Companies were called upon by the Lord Mayor to assist in defeating the designs of coal merchants who attempted to "engross" all sea-borne coal coming into London, and so raise its price when the demand was greatest. To defeat this purpose each of the trading companies was required to keep in store a quantity of coal proportionate to its *wealth*. The Grocers on this occasion were required to keep 675 chaldron, while the levy on the White Bread Bakers was only 45 and on the Brown Bread Bakers 12 chaldron. This seems to have been a regular method of taking precautions against scarcity. The City authorities frequently called upon

Small Influence of Company.

Company Preventing "Corners".

all the Companies to provide corn, which was stored in great granaries, the principal of which were at Bridgehouse and Leadenhall. "The wardens of the Bakers were admonished to make diligent labour and means for some competent provision of wheate, and subsequently delivered in an account of all the meal in store or bargaine provided by them and the Stratforde bakers." Stow tells of a time when there was a scarcity of wheat so great that, "when the carts of Stratford came laden with bread to the City, as they had been accustomed, there was such press about them, that one man was ready to destroy another in striving to be served for their money". This was in 1512, but the mayor of that day, one Roger Achley, was a man of energy and resource, for he "made such provision of wheat, that the bakers, both of London and Stratford, were weary of taking it up, and were forced to take up much more than they would, and for the rest the Mayor laid out the money and stored the wheat in Leadenhall, and other garners of the City". From this it is evident that the Bakers' Company was not allowed privileges without responsibilities.

Stores of Grain.

Great Scarcity in 1512.

It has probably never been a part of the rights of the Company to set the price of bread, although, as already noticed, it was entrusted with powers of search and supervision over the trade with regard to price and weight after the assize was duly set by the mayor and aldermen, or by the magistrates in counties. The Bakers do not seem to have exercised this supervision with the strictness which those in higher authority thought necessary, or else the latter were jealous of fines going into the funds of the Bakers' Company rather than into the coffers of the City courts, for the Company gradually lost its powers, and about the year 1730 we find the Bakers appealing to be heard before the Bar of the House of Commons against the scant consideration they received from the magistrates, and against those magistrates setting the assize without consulting the Bakers' Company. Their right to be so heard was undoubted, and is distinctly stated in the Bread Act, 3 Geo. I: "Before any reduction is made in the Assize of Bread by the Court of Lord Mayor and Aldermen, &c., a copy of the prices delivered in by the head weigher for the City for the time being, shall be left at the Common Hall of the Bakers' Company, for the space of 12 hours before any such reduction, to the intent that the said Company shall have opportunity to be heard thereupon before the Court".

Powers of Bakers' Company.

Bakers' Appeal.

Right to be Heard.

The abolition of the assize of bread in the Act of 1822 took away the occupation of the Bakers' Company, and until quite recently it drifted further and further away from the trade to which it belongs, neglecting all its functions, but retaining the funds for the comfort and benefit of those who happened to be on its livery. Although the majority of the livery and the wardens have now no connection with the trade, there has, within the last dozen

Present Condition of Company.

years or so, been a return of interest in the old institution, and quite a number of well-to-do bakers have taken up the freedom of the Company by purchase, and now the retired bakers form a considerable proportion of the court and the commonalty. The Company has also renewed its interest to some extent in the trade by presenting gold and bronze medals for competition at the annual Bakers' and Confectioners' Exhibition, and by presenting the freedom of the Company to the successful students in bread and confectionery at the National Bakery School, Borough Polytechnic Institute, London. The income of the Bakers' Company does not exceed £2000 per annum. Part of this money is from charitable bequests of former freemen, and the Company has still a good many pensioners who are benefited from those funds. Like the other City companies, the Bakers' Company spends a good portion of its income on dinners for its members. The presentation of the medals, alluded to above, takes place each year at the Common Hall of the Company, when the trade is invited. Although reference has only been made to the Bakers' Company of London, the conditions as to powers and privileges of other incorporations of the trade, so far as the administration of assize laws was concerned, were much alike in all the cities and corporate towns of England.

Renewed Life in Trade.

Present Income and its Uses.

The Incorporated Trades, as they are called in Scotland, had much the same kind of powers over craftsmen as the guilds and companies had in England. They fined those who broke their rules, enforced apprenticeship, debarred any but tradesmen from entering the business, and kept watch and ward over both the honesty and the morals of their members. Like their English brethren they acquired property, and grew rich by its natural accumulation. The richest Incorporations of Bakers in Scotland are those of Aberdeen and Glasgow. The former was fortunate enough to own a large piece of land which was adapted for a graveyard, and the income from this and other sources now enables the Incorporation to dispense a good deal of assistance amongst "decaied" tradesmen, and also to entertain on a lavish scale those who are not decayed. The Glasgow Incorporation of Bakers is probably even richer, and it acquired the greater part of its property in a manner slightly more heroic. In 1568, just before the battle of Langside, the army under Regent Murray, which opposed that of Queen Mary, was quartered near Glasgow. On this occasion the bakers of Glasgow were required to provide an extraordinary supply of bread for the troops. The flour supply was not sufficient for such an emergency, but the bakers, by uncommon exertions in bruising and bolting the grain, not only in the mills but also in their own houses, accomplished the task, and, in consequence, gave great satisfaction to the Regent. The latter being completely successful at Langside, remembered on his return to Glasgow the service of the bakers, and at a public thanksgiving he thanked the council and the incorporated trades, particularly the bakers,

Incorporated Trades of Scotland.

Aberdeen Bakers.

Glasgow Bakers and Battle of Langside.

for the service they had rendered him, and asked if there was anything he could do in return. The bakers were at the moment fortunate in having a deacon who could rise to the occasion in the person of Mr. Matthew Fawside. He informed Regent Murray that the bakers who had served him so well were the victims of the taxmen of the Partick and other mills, who exacted exorbitant multures, which greatly affected the price of bread to the community, and if he, the Regent, would give the Incorporation of Bakers a grant of Partick Mill, which belonged to the Crown, it would be acknowledged as a public benefit. The oration, we are informed, had the desired effect, and the Regent instantly gave the corporation a grant of the mill and certain lands connected with it. The bakers built a new mill on the site of the old one in 1664. The old mill was known as the Archbishop's Mill, but the new one was named the Bunhouse Mill, from the Bun and "Yill" house which stood at the gate. In the gable of the new mill a stone was inserted, with the inscription M—1568—F, in honour of the doughty Deacon Fawside. In 1771 the Bakers bought from the Town Council of Glasgow another mill at Clayslaps, and one interesting point about this mill is that it was almost, if not quite, the first flour mill in the kingdom to have a steam engine, which was of 32 horse-power and was considered a wonder. In 1895 the Incorporation of Bakers sold the Bunhouse Mill and adjacent lands to Glasgow Corporation for a sum of £50,000, so that the funds for charitable and other purposes are considerable.

Pawky Matthew Fawside.

Wealth of Glasgow Bakers.

First Steam Engine in Mill.

None of the ancient guilds or incorporations now identify themselves closely with the trade. The general interests of bakers are at present looked after by voluntary associations, some local, some national. Of the large associations the London Master Bakers' Protection Society, which has a membership of about 1500, is the oldest, having been started in 1866. The National Association of Bakers and Confectioners, which concerns itself with the whole trade of Great Britain and Ireland, and has a membership of about 5500, was started in 1888, its original home being Birmingham. The Scottish Association of Master Bakers, started in 1891, has a membership of over 2000, and was an offshoot of the National, its originators being seceders from the latter. All the large associations have done good work in watching over the interests of the trade in the matter of legislation and restrictive by-laws of local authorities. On one occasion, in 1896, the National Association was instrumental in preventing harassing regulations regarding the weighing of bread being inserted in the Weights and Measures Act of that year. In 1906, in conjunction with the London Master Bakers' Protection Society and a syndicate of West End London bakers, the National Association opposed successfully an attempt of the London County Council to reintroduce fixed weights for bread. Within the last few years an association called the South Wales Federation, consisting

Present Societies.

Protective Work of Societies.

of local associations, has acquired great strength in the district which gives it its name. It deals principally with the price question, and uses its corporate power to keep down underselling, by securing the assistance of millers and by preventing, as far as possible, those who undersell from obtaining flour supplies. The National Association has, with the assistance of the London Protection Society and the Borough Polytechnic Institute, done a good deal for trade education within the last eight years. The National Bakery School was started as a private venture by Mr. John Blandy, but was taken over by the National Association of Bakers, and is now managed by the latter body most successfully. On somewhat similar lines a bakery school has been started in Glasgow by the Glasgow and West of Scotland Technical College, in which the Scottish Association of Master Bakers and the Scottish trade generally have rendered valuable financial help. In addition there are local trade classes in many parts of the country.

Restrictive Work of Society.

Educational Work of Societies.

Bakery Schools and Classes.

Probably the greatest educational institution which the baking and catering trade has is the Annual Exhibition held at the Agricultural Hall, London, every September. Every baker in the kingdom who can spare the time and money endeavours to get to London for this event. Bakery engineers make strenuous efforts to have their latest machinery on show, merchants strive to produce their best wares here, whilst the bakers themselves spare no efforts to produce the best that skill and patience can accomplish for competition for the various valuable prizes and trophies here offered. This exhibition has probably induced greater changes and greater activity in the baking and allied trades than anything else. The baking, confectionery, and catering trades are supplied with a trade press enterprising beyond the ordinary, and its educational influence is enormous. There are no less than four weekly, three monthly, and one quarterly journal specially devoted to these trades, besides several others concerned more particularly with cooking and hotel work.

Influence of Exhibition.

Trade Press.

CHAPTER IV

WHEAT AND OTHER CEREALS: NATURE AND PROPERTIES

According to the botanical system, all the cereals belong to the order of Grasses. Whether they have been evolved from the primitive or wild grasses by cultivation, or are distinct species, is, however, a question still involved in some doubt. Like most of the wild grasses, the cereals are hermaphrodite, that is to say, the same blossom bears both male and female elements, though often one or the other is abortive.

Botanical Position of Cereals.

In the grass tribe the germ, as the young plant is called, is always

provided with a store of nutritive material, to ensure its support during the period of germination, and it is in this accumulation of reserve substance that man finds an abundant supply of food. Externally the cereal grains closely resemble seeds, but a closer examination shows them to be true fruits. Each grain consists of a fruit-leaf with its edges rolled over and grown together, the furrow which runs the length of the grain being the line of joint; this is well marked in the wheat berry.

Grains are Fruits.

The fruit consists of two important parts: the first, called the *endosperm*, with its coatings, comprises about 98·5 per cent of the entire grain; the second, the *germ* or embryo plant, makes up the remaining 1·5 per cent of the grain. The germ is embedded upon the base of the endosperm, on the dorsal side. A detailed account of the anatomy of the cereal grains will be given when dealing with wheat, which may be considered as typical of the group.

Chemical Constituents of Cereals.

All the principal nutritive substances are found in the cereals, though the proportions vary slightly in the different members. The greatest variations in chemical properties are found in the proteids; it is probable, however, that the nutritive properties are about equal. The total amount of proteids varies in the cereals from 10 to 12 per cent, but it should be noted that the whole of the combined nitrogen is not present in the form of proteids, a certain amount, especially during germination, existing in organic ammonia compounds or amides.

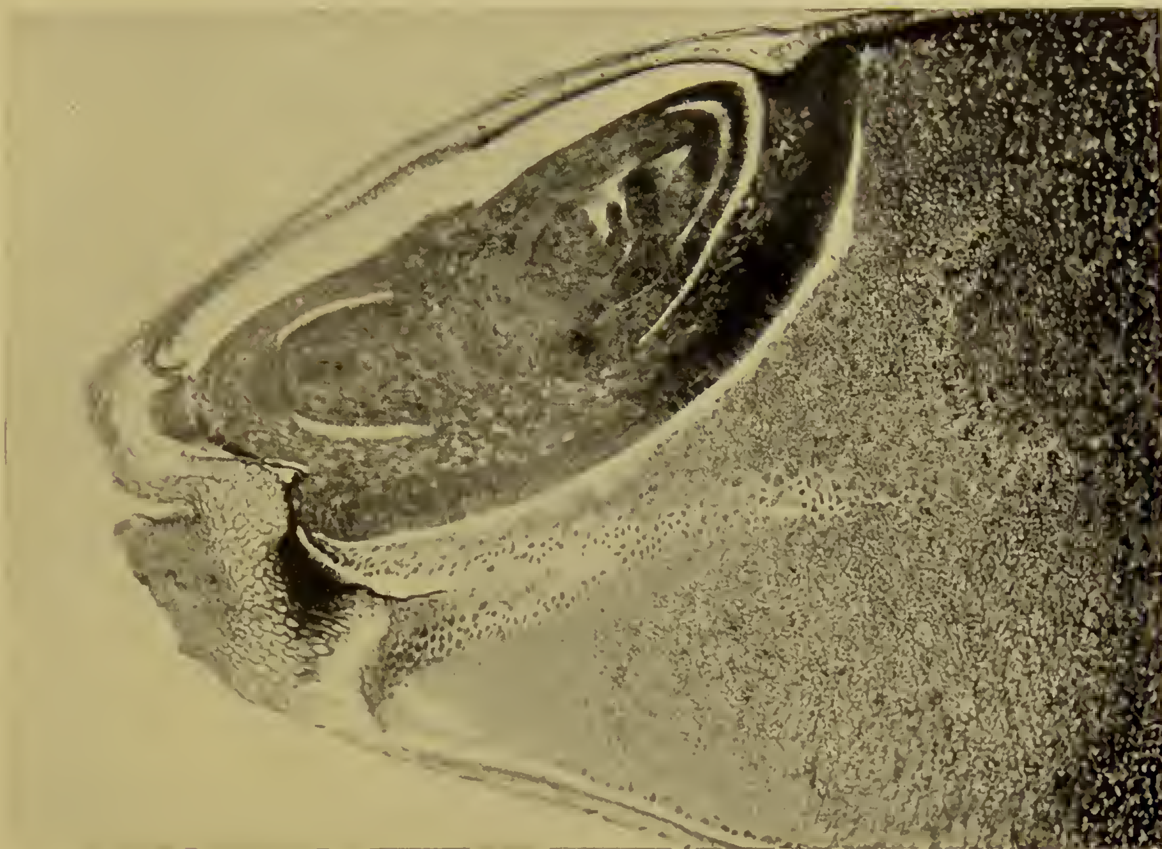
The chief carbohydrate in all cereals is starch; between 65 and 80 per cent of the whole grain is made up of this substance. Sugars, dextrin, and gums are also met with in small quantity, whilst many different kinds of cellulose go to form the various protective coats. Fat is present only in small quantity, and the cereals cannot be regarded as being in any way valuable sources of this important food stuff. The quantity varies considerably in the different members of the group, being most abundant in oats, and least so in rice. In this respect we find a curious parallel in the animal world, the greatest supply of fat occurring in those living in cold climes, whilst in warmer latitudes the quantity is relatively low. The mineral matter in cereals consists principally of the phosphates of lime and potash. Organic salts are present in very small amounts.

The general composition of the cereals varies between the following limits:—

Water	10 –12	per cent.
Proteids (nitrogenous matter) ...	10 –12	"
Carbohydrates (starch, sugars, gums)	65 –75	"
Fats	0·5– 8	"
Insoluble fibre	2 – 4	"
Mineral matters	0·5– 2	"

Relative Position of Cereals as Foods.

The following table will show at a glance the relative richness of each of the cereals in the important food principles:—



LONGITUDINAL SECTION OF WHEAT, SHOWING ENDOSPERM, CEREALIN CELLS, AND GERM

TRANSVERSE SECTION OF WHEAT, SHOWING ENDOSPERM, CEREALIN CELLS, GERM, ETC.

MICRO-PHOTOGRAPHS OF SECTIONS OF THE WHEAT GRAIN

No.	Proteids.	Carbohydrates.	Fats.	Mineral Matters.
1	Oats	Rice	Oats	Barley
2	Wheat	Rye	Maize	Oats
3	Rye	Wheat	Rye	Rye
4	Barley	Barley	Wheat	Wheat
5	Maize	Maize	Barley	Maize
6	Rice	Oats	Rice	Rice

WHEAT (Ger. *Weizen*; Fr. *Blé*), *Triticum vulgare.*—This is by far the most important cereal in this country, it being estimated that 6 bushels per head is consumed by the population every year. Although the staple grain of the Western races, wheat must nevertheless be placed second to rice in point of numbers supported by it, for rice is the staple food of the people of China and Japan, and is also a leading food crop in India.

Parts of Wheat Grain.

By reason of the marked physical characters of certain of its proteid constituents wheat is pre-eminently the cereal of the bread baker, and a close study of the anatomical and chemical structure of the wheat berry is necessary in order to understand the processes by which the many grades of flour required in practical work are produced. If a grain of wheat is carefully cut into two by passing the blade of a knife through the furrow, it will be seen, upon examining the cut surfaces, that the grain consists roughly of three different parts. Upon the outside is a thin yellowish to brown skin, completely surrounding the chalk-like material that forms the bulk of the corn. At one end, embedded in a small recess, a small bright yellow body will also be noticed. Now, if a very thin slice is removed from one of these surfaces, and, after mounting in water, examined under a microscope furnished with $\frac{1}{4}$ and $\frac{1}{6}$ powers, the following parts may be recognized by careful searching (see Plate, SECTIONS OF WHEAT GRAIN).

Skins of Wheat.

Magnified by the $\frac{1}{6}$th power, the skin will be seen to consist of several layers differing only slightly in structure. In all there are five of these skins, but it will be found somewhat difficult at first to differentiate them clearly in the section. By soaking a grain in water for some hours the different skins can be easily stripped off; they may then be examined separately. Another method consists in boiling a little bran with dilute acid for a few minutes, then collecting the finer particles and mounting them.

The first three coats constitute the coarse skin or bran, the outermost being the *epidermis* or *cuticle.* The *epicarp* and *endocarp*, forming the next two layers, are composed of reticulated cells. It should be noted that the cells of the epicarp run in the direction of the length of the grain and are coarse in structure, whilst those of the endocarp are finer and more delicate and run transversely.

Immediately beneath the endocarp is the very thin skin called the *episperm*, or *testa*, or sometimes the hyaline coat. This skin is the true

envelope of the grain, and in it is found the colouring matter which marks the corn as belonging to the white or the red wheats. The structure of the testa differs from that of the previous coats in the shape of its cells, which are long and narrow, with rounded or loop-like ends.

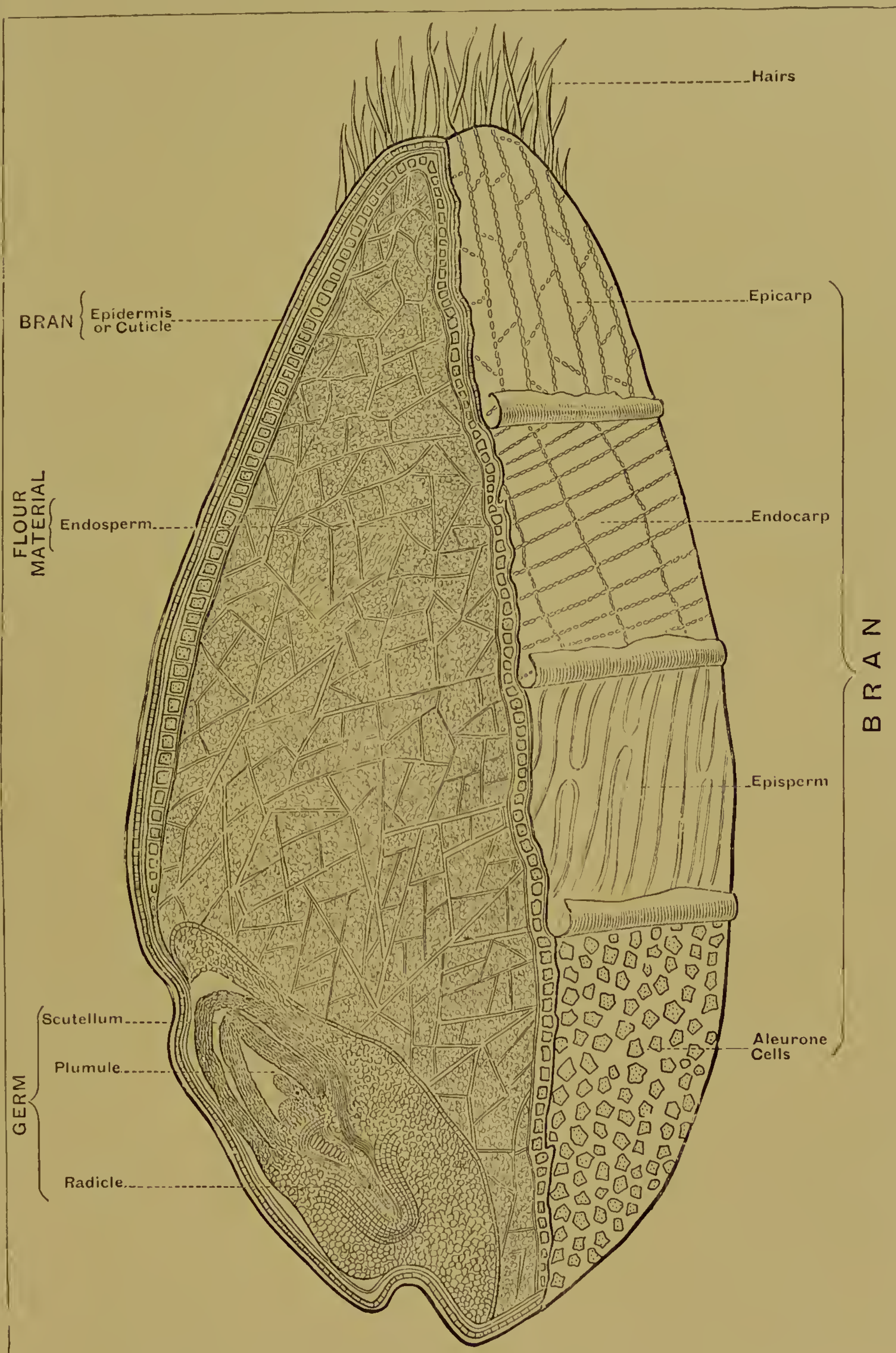
The next series of cells is called the *aleurone* or *cerealin layer*, and, although usually considered as belonging to the bran, it strictly forms part of the endosperm. In the wheat berry there is only one row of aleurone cells; in shape they are almost square when seen in transverse section, and polygonal in surface view, somewhat like the cells in a honeycomb. These cells are packed with proteid and fatty matter. At one time they were thought to be the seat of the gluten, and for many years they were called the gluten cells. The material in these cells has now been shown to consist of oil globules and amorphous proteid, so that the term aleurone is now also a misnomer. The proteids in this layer exert a considerable and undesirable influence upon the dough during fermentation, and for this reason the miller tries to exclude them from the flour. The aleurone layer, therefore, is removed as far as possible with the offals.

Structure and Composition of Germ.

The germ, a complex and beautiful structure, will amply repay a very close study. The cells are small and of a pale-yellow colour. There is no starch in them, the chemical compounds present being chiefly proteids and fat. When viewed with a low power (1 in.) the outline of the young plant may be seen strongly marked. The germ consists of three distinct parts (see Plate, DRAWING OF WHEAT BERRY): (*a*) the *plumule* consists of the undeveloped leaves of the future plant; (*b*) the *radicle* is the root centre, the primitive root bulb being quite distinct; (*c*) the third part is called the *scutellum*, and comprises the series of slightly elongated cells lying next to the endosperm. The scutellum performs the important function during germination of conveying the nutritive materials of the endosperm to the young plant. Those cells of the scutellum in immediate contact with the endosperm are sometimes called the epithelial cells, and it is in these that the active agents (enzymes) are formed which transform the starch and proteids of the endosperm into soluble matters capable of absorption by the growing plant.

Germination of Wheat.

The chemical changes which wheat undergoes in the process of germination consist in rendering both starch and proteid soluble; consequently flour which is made from germinated wheat does not produce bulky, good-coloured bread. Before grinding, sprouted wheat can be detected microscopically by examining the germ, which will be found to contain starch if germination has commenced. When flour has to be examined for this change, the amount of soluble matter present should be noted, and if more than 5 per cent is found, the flour must be regarded with suspicion. It is sometimes possible to detect sprouting by the microscope. Examine a water-mounted sample of the flour with a high-power lens, when the starch grains will appear as if scored over by a tiny worm. This appearance is due to erosion of the cell walls of the starch grain by the enzyme cytase. The process of malting wheat and barley consists



DRAWING OF WHEAT BERRY, SHOWING PARTS

in starting the grain to germinate under artificial conditions; during this process considerable quantities of diastase are secreted, and some of the starch is also rendered soluble. When these changes have proceeded far enough, the maltster arrests further action by drying the grain in kilns.

The endosperm contains the whole of the materials which are of importance to the baker. When highly magnified, it will be seen to consist of numerous large cells of net-like form, in which starch grains are tightly packed, the whole endosperm being thus divided up into compartments. The walls of these compartments are built up of a very delicate thin cellulose; it is this material which forms the "fluff" of the dust-settling rooms in flour mills. In addition to starch the endosperm cells contain both soluble and insoluble proteids, sugars, and salts; it is not possible, however, actually to see these other constituents, but it is probable that they are deposited in the form of fine powder upon the starch grains and in the spaces between them.

Structure of Endosperm.

The proteids consist partly of soluble albumen and globulin, of which there is only a small percentage in wheat, the remainder being insoluble proteid or gluten. The insoluble proteids of cereals have been separated by means of alcohol into two constituents called *glutenin* and *gliadin*, and it is believed that this latter body gives to gluten its characteristic properties.

Proteids of Wheat.

The following table, published by Fleurent in *Comptes Rendus, 1901*, shows the ratio which these two substances bear to one another in the insoluble proteids of the common cereals. It will be noted that in wheat the gliadin amounts to about two-thirds of the total, and in no other case does it reach so much as one-half.

Relation of Gliadin to Glutenin.

Cereals.	Insoluble Proteids. per cent.	Consisting of	
		Gliadin.	Glutenin.
Wheat	6 to 14	62·68	38·18
Rye	8·2	8·17	92·83
Maize	10·6	47·50	52·50
Barley	13·8	15·60	84·40
Rice	7·8	14·31	85·70
Buckwheat	7·2	13·00	86·90

The gluten appears to be distributed throughout the whole endosperm, though in a decreasing proportion towards the centre, for it is found that the best roller patents which are made from the heart of the endosperm generally possess less gluten than lower-grade flours, such as bakers' or straight grades, which contain much flour made from the outer portions of the endosperm.

The starch grains in wheat are round or slightly oval in shape, and

vary in diameter from ·035 to ·039 mm. Rings are indistinct, and the hilum, which is a tiny dot near the centre, cannot always be seen. (See Plate, STARCHES.)

The relative proportions of the different parts to the whole berry are usually given thus:—

Endosperm	85·0
Bran	13·5
Germ	1·5
	100·0

The following table, compiled from a number of analyses, shows the chemical composition and proportions of the component parts of the wheat berry:—

	Proportion of whole Berry.	Moisture.	Nitrogenous Matter.	Carbohydrates.			Fat.	Lignin or Fibre.	Mineral Matter.
				Sugars.	Starch.	Cellulose.			
Cuticle ...... Epicarp ...... Endocarp	4·2	0·475	0·362	—	—	—	—	3·309	0·080
Episperm	1·1	0·131	0·178	—	0·723		—	—	0·060
Aleurone layer	8·2	1·115	2·048	—	—	3·997	0·748	—	0·452
Germ............	1·5	0·173	0·538	0·332	—	0·144	0·187	—	0·070
Endosperm	85·0	11·050	8·925	1·500	61·635	0·590	0·680	—	0·590
	100·0	12·944	12·051	68·921			1·615	3·309	1·252

These results show clearly that the great bulk of food materials lies in the endosperm. The bran coatings are relatively rich in cellulose, lignin, &c., bodies which are practically indigestible. It must also be remembered that simple chemical analysis cannot give any adequate idea of the degree of digestibility. The results of direct digestive experiments have demonstrated the fact that the nitrogenous matter of the bran (with which the aleurone layer is usually included) is only absorbed to a very slight extent in the alimentary tract. The germ, although undoubtedly rich in fat and proteid, is present in such small quantity that the total addition to the nutritive value resulting from its inclusion in the flour would be almost inappreciable. On the other hand, by reason of its large amount of fat and active proteids, the germ speedily becomes rancid, and imparts bad flavour to the flour.

Indigestibility of Bran.

Wheat, irrespective of its source, is of fairly constant chemical composition. The chief differences noticeable are found between the spring or summer and the winter wheats, these names being given to those crops obtained from seed sown in spring and autumn respectively.

The following averages are given by J. König as the results of many hundreds of analyses of wheats grown in all quarters of the globe:—

Origin of Samples.	Water.	Proteid.	Carbo-hydrates.	Fat.	Cellu-lose.	Salts.
England	13·3.	10·99	69·21	1·86	2·90	1·67
Scotland	13·3	10·58	72·77	1·73	—	1·55
France	13·3	12·64 (?)	68·92	1·41	2·00	1·66
Germany	13·3	12·29	67·96	1·71	2·82	1·85
India	13·3	10·99	70·19	2·08	1·92	1·45
Australia	13·3	10·16	—	1·39	—	—
Russia	13·3	16·75	64·40	1·58	2·19	1·71
N. America (504 analyses) ...	13 3	11·61	69·46	2·07	1·70	1·79
All Countries (948 analyses) ...	13·3	12·03	68·67	1·85	2·31	1·77
Winter Wheats	13·3	11·64	69·07	1·72	2·34	1·86
Summer Wheats	13·3	11·38	69·29	2·00	1·81	1·94

Rye (Ger. *Roggen*; Fr. *Seigle*), *Secale cereale.*—Rye ranks second only to wheat as a bread-making grain. Its inferiority to wheat in this respect is due to the smaller quantity and the different character of its gluten, with the correspondingly larger amount of soluble proteids. This deficiency of gluten, coupled with an increased diastasic activity resulting from the large amounts of soluble proteid, has the effect of rendering bread made from rye flour close, damp, and poor in volume, perhaps also imparting its slightly sour taste.

Structure and Character of Rye.

Rye bread is largely used in Russia, Germany, Austria, and other Continental countries. In digestibility the finer varieties are probably equal to wheaten bread, but the coarser kinds, *e.g.* pumpernickel, owing to a less careful milling of the flour, contain much bran, and are more indigestible. It is estimated that 42 per cent of the proteids of pumpernickel escape digestion.

Rye is similar in structure to wheat, but the individual grains are narrower and of darker colour. This difference enables rye to be separated from wheat by screening with a sieve having narrow slits, too small for wheat, but large enough for rye to pass through. The hairs of rye grains are longer and less regular than those of wheat. Rye starch is similar in shape to wheaten, but a trifle larger, on the average varying from ·039 to ·052 mm. Many of the largest starch grains often show a curious triangular fissure radiating from the hilum. Rye is peculiarly liable to the fungus disease Ergot (see p. 41).

The limits of variation in the composition of rye are as follows:—

	Water.	Proteid.	Carbo-hydrates.	Fat.	Cellulose.	Salts.
Minimum	13·24	11·19	69·36	1·35	2·16	1·83
Maximum.........	13·37	11·63	69·52	1·68	2·43	2·24

Gluten can only be washed out of rye flour with difficulty. The colour of the wet gluten is dirty grey, and it softens much quicker than wheat

gluten. The dark colour of rye bread is doubtless in part due to this poor colour of the gluten, although rye flour is not milled for the purpose of securing whiteness. It is only a "straight" grade.

Gluten of Rye.

Barley (Ger. *Gerste*; Fr. *Orge*), *Hordeum vulgare*.—This grain differs from both wheat and rye in that it is closely invested by its chaff, for which reason it is classed with the spelts. The spelts, sometimes called the chaffy wheats, are now of but small importance, though at one time they formed the leading cereal of ancient Egypt, Greece, and Rome. The principal difference between them and the common varieties of wheat now cultivated is found in the fact that the threshed grain is not naked, as is the case with wheat and rye, but remains enveloped in its husk like oats and barley. In barley, the aleurone layer consists of four rows of cells, instead of the single one in wheat and rye. Like rye, it is deficient in gluten, only small quantities of which can be obtained by washing.

Structure of Barley.

The starch of barley is similar in shape to that of wheat and rye, and is slightly smaller than wheat starch, the large grains being about ·026 mm. in diameter. (See Plate, Starches.)

At one time barley was a good deal used in England for bread-making, mixed with wheat flour and rye, and it is still extensively employed in the north of Europe. Since the middle of the last century, however, its use has steadily declined in favour of wheat.

The limits of variation in the composition of barley are given in the following table, where it will be noted that the cellulose and salts are both high compared with wheat:—

Composition of Barley.

	Water.	Proteid.	Carbo-hydrates.	Fat.	Cellulose.	Salts.
Minimum.........	14·78	8·22	67·07	1·54	3·38	2·39
Maximum........	15·97	8·49	67·34	2·42	4·72	3·67

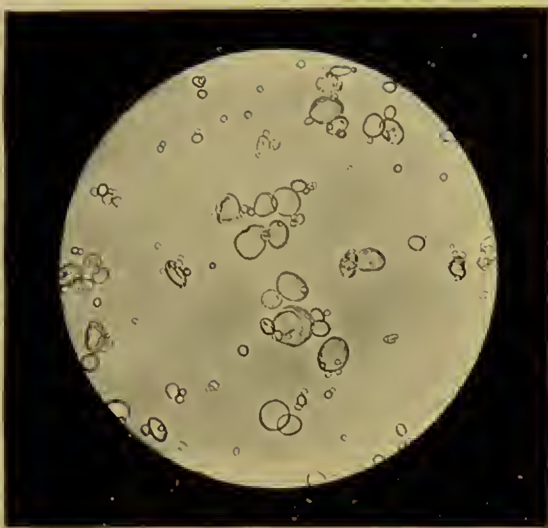
Oats (Ger. *Hafer*; Fr. *Avoine*), *Avena sativa*.—Like barley, this grain belongs to the spelts. The husk of oats is very adherent to the grain, and it is necessary to kiln the oats in order to divest the grain of it. Oats are very rich in proteids, but as they do not form gluten, this cereal is quite unsuitable for bread-making.

Structure of Oats.

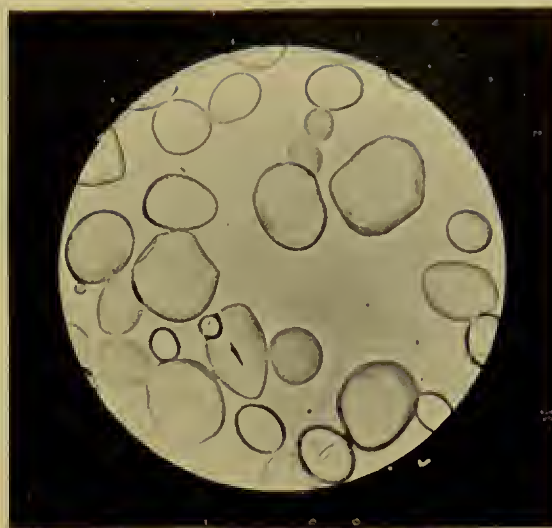
The starch of oats is characteristic, and enables it to be readily recognized. The starch grains are polygonal in shape, and exist in aggregates of two or more, forming rounded or elliptical bodies. The individual grains are very small, ·004 mm. being the average size.

The average composition of oats is given below:—

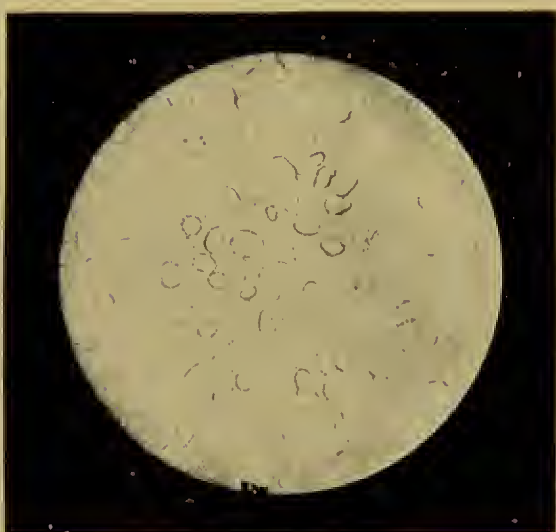
Water.	Proteid.	Carbo-hydrates.	Fat.	Cellulose.	Salts.
12·81	10·25	58·68	5·27	9·97	3·02



WHEAT

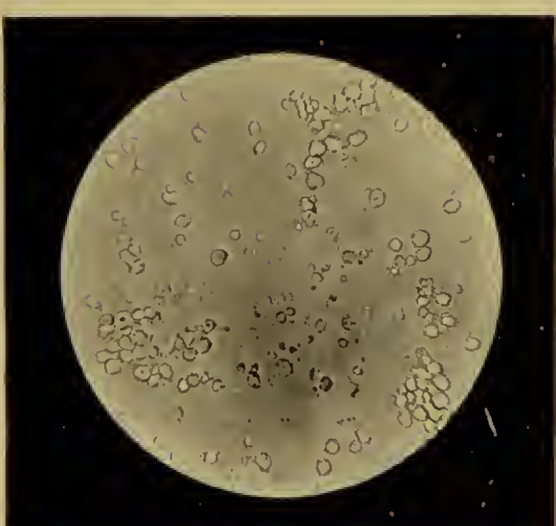


POTATO

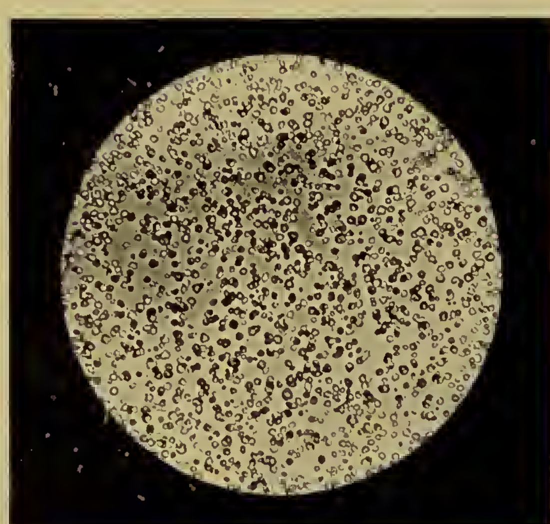


BARLEY

RYE



MAIZE



RICE

MICRO-PHOTOGRAPHS OF VARIOUS STARCHES

MAIZE (Ger. *Mais*; Fr. *Maïs*), *Zea Maÿs.*—Maize is not largely used as a human food in Europe, but in America and South Africa it is the staple food of the labouring and coloured people. During the potato famine it was largely imported into Ireland, where bread was made from it by using baking powder. It is deficient in gluten, but palatable though dark-coloured bread can be obtained from it if it is mixed with some wheaten flour. Maize is usually made into cakes, such as the Johnny cakes of America. There are many special preparations of maize flour in commerce, most of them being sold under fancy names. In these flours the nutritive properties of the maize are greatly reduced, because in preparing the cereal for market the fat and proteid are washed out by alkalies, in order to obtain a better-looking and more neutral-flavoured product. Such flours are indeed little else than starch.

Preparations of Maize Flour.

The starch of maize is similar in shape to oat starch, but larger. It does not form into aggregates. Maize starch feels gritty, owing to the slight angularity of its grains. In size, maize starch varies from ·02 to ·03 mm. Many of the largest grains exhibit a star-shaped fissure radiating from the hilum. (See Plate, STARCHES.)

The average composition of good maize is as follows:—

Water.	Proteid.	Carbo-hydrates.	Fat.	Cellulose.	Salts.
13·32	9·58	67·89	5·09	2·65	1·47

RICE (Ger. *Reis*; Fr. *Riz*), *Oryza sativa.*—Rice is cultivated mainly in tropical countries. It is the poorest of all cereals in fats and proteids, and the richest in carbohydrates. On account of its great deficiency in proteids, it is not possible to make bread of any kind from it.

Composition of Rice.

Rice starch (see Plate, STARCHES) is faceted, the grains being very small and closely packed together. The largest grains measure ·0066 mm., and show a distinct hilum in the centre. Rice has the following mean composition:—

	Water.	Proteid.	Carbo-hydrates.	Fat.	Cellulose.	Salts.
Unhulled rice....	12·18	6·3	69·28	2·0	6·51	3·57
Hulled rice.......	13·17	8·1	75·50	1·2	0·80	1·03

BUCKWHEAT (Ger. *Buchweizen*; Fr. *Sarrasin*), *Polygonum Fagopyrum.*
MILLET (Ger. *Hirse*; Fr. *Millet*), *Panicum miliaceum*, *P. italicum.*

Although not used in this country, buckwheat is often eaten in Continental countries, and millet is largely grown for food in India, South Africa, and China, where it is made into bread. Buckwheat cakes were at one time a foodstuff of the English labouring classes. The starch grains

of buckwheat are very similar in shape and size to those of rice, but they tend to form irregular aggregates, like oaten starch. Millet starch is like wheat starch in general appearance.

The composition of these cereals is as follows:—

	Water.	Proteid.	Carbo-hydrates.	Fat.	Cellulose.	Salts.
Buckwheat.......	13·4	15·2	63·6	3·4	2·1	2·3
Millet.............	13·0	15·3	61·6	5·0	3·5	1·6

Millet bread is equal in nutritive properties to wheaten.

CHAPTER V

THE DISEASES OF WHEAT, FLOUR, AND BREAD

From the earliest stages of its existence wheat, in common with all the cultivated cereals, is subject to the attacks of many enemies, both vegetable and animal. During the time that it is growing, the most formidable foes of wheat are to be found in certain diseases due to the growth of different species of fungi in or upon the grain. Many animal parasites also attack the corn at this stage.

Diseases in Grain.

When the grain is harvested and stored, the animal parasites become perhaps the chief source of loss. The ova deposited by moths upon the ears while growing germinate during storage of the threshed grain, and the larvæ thus formed prey upon the corn. At the same time certain new varieties of animal parasite gain access to the grain from the storehouse or granary, where they are practically normal denizens. Although many of these pests are of foreign origin, they may now be truly called cosmopolitan; for, like the Danish rat, they have been transported to every corner of the globe by the operations of commerce.

When made into flour, the corn is rendered slightly less suitable for the development and multiplication of such parasites, though on the other hand it affords a better medium for the growth of fungi, and also under certain conditions of bacteria.

Even when the flour is manufactured into bread, the whole of the dangers introduced at the growing stage are not disposed of, for it has been shown quite recently that the spores of some of the bacteria found in the soil can resist the action of the heat applied during baking sufficiently long to enable them to develop later in the bread if the conditions are favourable.

Diseases in Flour.

Of the animal forms which attack growing wheat little need be said here, since in most cases their ravages do not affect the resulting flour, except to limit its quantity.

Those creatures which deposit their ova upon the growing ears are often productive of great loss during storage; they belong to the Lepidoptera or moths. The larva or caterpillar, and sometimes even the moth itself, may be found in old samples of flour.

Corn Moth.

The Corn Wolf Moth (*Tinea granella*).—This is a small moth, about 13 mm. across the spread wings, and 5·5 mm. in length. The front wings are silvery mottled, and the back ones grey. The larva is about 9 mm. long, of a light buff colour, with a grey horny head. It is furnished with six feet and eight prolegs, and the body is covered with hairs. It spins a fine web-like cocoon.

The Wheat-flour Moth (*Ephestia kühniella*).—This moth is larger, being about 20 mm. across the wings. The upper wings are of a pale grey with dark markings, the under wings being semi-transparent. The larva is 15 mm. long when full grown, of a pale flesh colour, with head of yellowish-brown. It spins a web that sometimes causes considerable trouble in the mill, by felting the flour and causing clogging.

Corn Weevils.

More destructive to the whole corn, however, are the Coleoptera, or beetles and weevils. These creatures may be well termed the corn-dealer's pest, for they inhabit the wheat kernels during the larval state, eating out the whole interior, and afterwards boring their way through the husk. There are many varieties, but the most important are the corn weevils, *Calandra* (*Sitophilus*) *granaria* and *Apion frumentarium.*

Calandra (*Sitophilus*) *granaria* is the most dangerous. It is about 4 mm. long, of a black or dark-brown colour. The elytra (wing cases) are rounded at the ends, and dotted or striped. The head is furnished with a long, slender, trunk-like mandible. The larva is white, with a brown head, and without legs. The creature hibernates in the crevices of floors and walls of corn stores.

Apion frumentarium is a beetle of a yellow-red colour.

Rice Weevil.

Calandra oryzæ is a small weevil about 5 mm. in length. It may be recognized by four red spots upon the otherwise black wing cases. This weevil has been introduced from India in wheat cargoes. As its specific name implies, it is the rice weevil.

The Flour Beetle (*Tenebrio molitor*).—This beetle measures from 14 to 18 mm. It is of a pitch-black to brown colour. The wing cases are flattened, rounded at the ends, and dotted or striped. The beetle may be distinguished from the weevils by the long, slender antennæ of eleven joints. The larva of this beetle is the common meal-worm. It is of a shining yellow colour, the body very hard and smooth, having six legs.

Flour Beetle.

All these beetles greatly dislike light. The beetles and their larvæ can be readily separated from flour by sifting, but the ova will remain. Utensils and bins in which infested flour has been stored should be scalded out in order to exterminate the ova before putting in fresh flour. There is no definite evidence that these creatures affect the food value of the flour, apart from the loss of weight

sustained. Flour which has become infested is certainly of inferior bread-making quality, and has a harsh taste; but since the development of large numbers of these insects is generally a sign of age in the flour, it is quite possible that the inferiority is due to obscure chemical changes in the gluten, &c., brought about by the long storage.

Ear Cockle or Purples.

EAR COCKLE, PURPLES, or PEPPERCORN (*Tylenchus tritici*).—This peculiarly offensive disease is caused by a nematode or eel-worm. If a growing spikelet of affected corn is examined, it will be noted that many of the kernels have been replaced by small dark-green to black balls like peppercorns. On cutting such a ball open a cottony mass will be seen inside, which, if moistened with water and examined microscopically, is seen to consist of masses of tiny transparent worms, about 20 mm. in length and very thin with pointed ends. They are sometimes called vibriones. These worms are sexless, and pass one stage of their existence in the wheat cockle. Upon transfer to the soil, they attack the roots of the young wheat, piercing the tissues and feeding upon the juices of the plant. They here grow to maturity and pair, lay their eggs, and then die. The eggs again yield the sexless worms, which migrate to the ear, forming fresh cockles. These worms have a wonderful power of resistance to extremes of heat and cold; they have been known to preserve their vitality after being dried for twenty-one years. They may be frozen or heated to 52° C. (125° F.) several times without being killed.

The galls may be easily removed, since, owing to their difference in size and shape from wheat kernels, they pass readily through sieves which retain the wheat. It is stated that flour made from such wheat is decidedly injurious to both man and animal.

The dietetic properties of flour are greatly injured by the various cryptogamic plants or fungi which attack the wheat during its growth. These plants comprise the different forms of smut, ergot, bacteria, algæ, yeasts, &c. Flour infected with these parasites is frequently very offensive in smell and taste, and in most cases totally unfit for use as food.

Bunt or Stinking Rust.

BUNT, STINKING RUST (*Tilletia caries*).—This disease is practically confined to wheat. It is difficult to recognize in the growing corn, but the threshed kernels are seen to be small, with a dull greenish lustre. Upon crushing a grain between the fingers a dark powder is found to fill it. The powder feels greasy, and has a disgusting fish-like odour. If a portion is viewed microscopically, it is found to consist of numerous dark-brown spores, ·016 to ·02 mm. in diameter, or nearly the size of a wheat starch grain. The cell wall is studded with a number of tiny spines and the surface reticulated. It has been calculated that a grain of wheat can contain 4,000,000 spores.

Bunted wheat is used by millers, but only sparingly in mixings, because of the bad colour and odour which it imparts to the resulting flour. Some millers think that small quantities of such wheat increase the strength of flour, but no evidence is forthcoming in support of

this view. Whilst it is difficult to trace actual epidemics to its use, there is strong reason for believing that it may set up diarrhœa. On the other hand, fowls fed exclusively upon such wheat have not suffered in any way. There can be no doubt that it would be better to dispose of such wheat as fodder, rather than risk the possible consequences of using it for the manufacture of human food.

Rust or Corn Mildew.

RUST, CORN MILDEW (*Uredo rubigo vera*, and *Uredo linearis*).—The rusts are the most widely spread of all cereal diseases, the loss of crops due to them sometimes reaching from 50 to 75 per cent. Botanists group these diseases together under the head of the Uredineæ. The disease in all cases has two stages in wheat, known respectively as Rust and Puccinia. In the first or Rust stage, small pustules of a reddish colour are seen upon the stems and leaves of the plant. These in time disappear, and are replaced with black patches. The pustule is caused by the growth of the sori or spore heads under the integument, which is thus forced up into a small bleb; this finally ruptures and allows of the escape of the spores. The spore of the Rust stage is small, round, and black; it gives rise to the second or Puccinia stage, which in its turn produces a form of double spore (teleutospore) with pointed end. Rust is now known to be a disease communicated to wheat from barberry bushes, upon which this fungus passes a third stage of its existence, and forms resting spores which germinate only after some months, producing the Rust stage in the grasses. There are two kinds of Rust with their respective Puccinia; they are known as Spring Rust (*Uredo rubigo vera*) and Summer Rust (*Uredo linearis*). Recent researches bearing upon Mendel's theory of heredity have shown that the liability to this disease is inherited, and, therefore, that selection of resistant varieties offers a prospect of stamping this disease out.

Smut.

SMUT (*Ustilago carbo*) is also a very common disease of wheat, and in bad cases as much as one-third of the crop may be destroyed. Smut appears to attack the plant at the root, thence passing upwards into the ears, which become covered with a sooty deposit consisting of the spores. These spores are very small, about ·005 mm., quite round, and perfectly smooth, dark-brown in colour. They are capable of reproduction by budding, and in this they closely resemble the yeasts. The disease is common to a large number of grasses, and its spores may often be found in flour in small number. Smut has no smell, but if smutted wheat is used in large quantity the colour of the flour suffers. Experiments in feeding smutted wheat to animals have had no injurious results. Nothing is known of its effects upon the human system, but it is said to impart a disagreeable flavour to bread if present in large quantity.

Ergot.

ERGOT (*Claviceps purpurea*).—Dietetically this is by far the most dangerous of the cereal diseases. Ergots are small, blackish, cucumber-like excrescences, which may be sometimes seen growing from the ripening ears of rye, and, less frequently, wheat, barley, &c. An ergot is really the sclerotium or hard mycelium of the fungus *Claviceps*

purpurea. When cut, the interior of an ergot is seen to be white or pinkish with dark-purple veinings; it has a faint camphor-like odour, and bitter, nauseous taste. Its thick-walled cells are filled with a dark viscid oil. If kept upon damp soil ergots germinate, giving rise to a true fungoid growth of hyphæ, upon which fine purple heads appear. The surface of each head has numerous little sacs in it, which, when examined in section, are seen to be packed with long, narrow, glittering spores. In June, when rye and other grasses are in bloom, these spores are ejected in thousands, and some find a resting-place in the flowering grasses, where they give rise to fresh ergots. Ergots retain their vitality two years.

When taken in any quantity, ergot gives rise to serious disease, gangrene of the extremities being its worst form. It also causes severe muscular contractions; in small animals this contraction is sometimes so violent as to cause death of itself. It is used in medicine by reason of this property. Ergotism has been rare in Britain, but on the Continent it was at one time quite common. It was computed some years ago that in France fully one-fourth of the rye used by the poorer classes for bread-making was ergotized, and no attempt was made to separate it. Upon no account should ergotized flour be used in the preparation of food for human consumption.

Flour is subject to one or two pests which are practically confined to the bakehouse. Of these the cockroaches are perhaps the worst. The commonest forms are *Blatta germanica* and *Periplaneta orientalis*, the latter the common cockroach or so-called black beetle. These creatures are nocturnal and dread light. They have long, flat, oval bodies, and are of a brown to black colour. *Blatta germanica* is 11 mm. long, with two black bands on a broad scutellum. The antennæ are as long as the body. It has been displaced in many places by the larger *Periplaneta orientalis*, which is 26 mm. long, and of a chestnut colour, with rusty-coloured wings. *Blatta americana* is the largest of all these pests, being 30 to 40 mm. long, and of a shining rust-brown colour. It is frequently imported with flour.

Cockroaches.

Another pest in many bakehouses is the so-called silver-fish (*Lepisma saccharina*), an insect belonging to the group of Thysanura or Bristle-tails. It is a very small, active creature, with slender, silvery, shining body. There are two beautiful brush-like appendages to the tail. Another species of the same group of insects, called *Thermophila furnorum*, frequently infests bakehouse ovens.

Silver-fishes.

The extermination of these pests is a perpetual problem to the baker, and all sorts of proprietary remedies are adopted with scant success. The success which has attended the introduction of bacterial cultures, capable of producing epidemic disease among rats and mice, encourages the hope that further investigation by the bacteriologist will enable these equally repulsive creatures to be similarly eradicated.

The Flour Mite is *Tyroglyphus siro*, sometimes known as *Acarus farinæ.* The presence of this parasite is always a sign that the flour is

unfit for use as food. The mite has a small egg-shaped body, whitish in colour. It has eight legs of a reddish colour. Flour which is infested becomes brownish and specky. If preserved in a bottle, the sides of the flour next the glass will be found covered with fine lines radiating in all directions, these being the channels burrowed in the flour by the insect. The flour will usually be found to smell musty. The insect can be seen with a small magnifying glass, but its ova need a microscope for their detection. Even if such flour has been blended with sound flour, the microscope will reveal the debris of dead insects and the ova.

Flour Mite or Acarus.

Mould fungi do not attack flour until it has become damp and is quite beyond use. Very old damp flour often develops white moulds, which are members of the Oïdium group. The flour smells strongly, often like ammonia.

The commonest bread disease is undoubtedly sourness. It has been shown that this sourness is due to excessive development of acetic, lactic, and butyric bacteria (see Plate, YEAST, &c.). These organisms are always present in yeast, barm, and leaven. In normal fermentations they do no harm; indeed it is possible that they perform a useful function by assisting in producing flavour, and modifying to some extent the glutinous portion of the dough. It is only when the conditions become unfavourable to yeast, either by alterations in temperature or by pushing fermentation too far, that the odour or taste of the products of these bacteria becomes pronounced, and the bread is sour.

Bacteria of Sourness.

BACILLUS LACTIS (see Plate, YEAST, &c.).—This term is now used to cover a large group of organisms, all of which possess the property of producing lactic acid. It has been estimated that at least 100 different bacteria possess this power. Lactic acid organisms produce appreciable quantities of acid only at high temperatures. The bacteria are most active at temperatures between 35° and 42° C. (95° to 107° F.). When the amount of free acid present reaches 2 per cent the further growth of these organisms ceases. Lactic acid germs do not form spores, and are consequently readily killed by pasteurizing or at the temperature of baking ovens.

Bacillus lactis.

BACILLUS BUTYRICUS (see Plate, YEAST, &c.).—Many organisms possess the property of producing butyric acid among other substances. The best-known member of the group is the *Clostridium butyricum* of Prazmowski. Pasteur was the first to show that butyric fermentation took place in two stages, the first being the production of lactic acid by its specific organism, and the second stage consisting in the conversion of the lactic into butyric acid by butyric organisms. These organisms are mostly anaërobic, that is, they flourish only in the absence of free oxygen. Indeed, air is sufficient to paralyse their action. Some of them, however, are capable of existing in the presence of air, though in depressed activity; they are consequently called facultative anaërobes.

Bacillus butyricus.

The butyric bacilli flourish best at 40° C. (104° F.). They form spores which resist boiling temperatures for several minutes. Some of them possess the power of dissolving cellulose and may therefore attack starch.

Mycoderma Aceti (see Plate, Yeast, &c.).—In flour and mixed with yeast there may be small quantities of germs which produce acetic acid from alcohol. These cells are extremely minute, and are generally joined together in the form of curved rods or chains. They grow by fission, that is, the full-grown cell divides across and forms two or more cells, which do the same when they grow to maturity. It performs its functions under conditions somewhat similar to those of yeast, the range of temperatures being between 62° and 88° F.

Many other species of bacteria have been isolated from dough during fermentation, but as no specific disease has been clearly traced to them, it is not necessary to make more than passing reference to them.

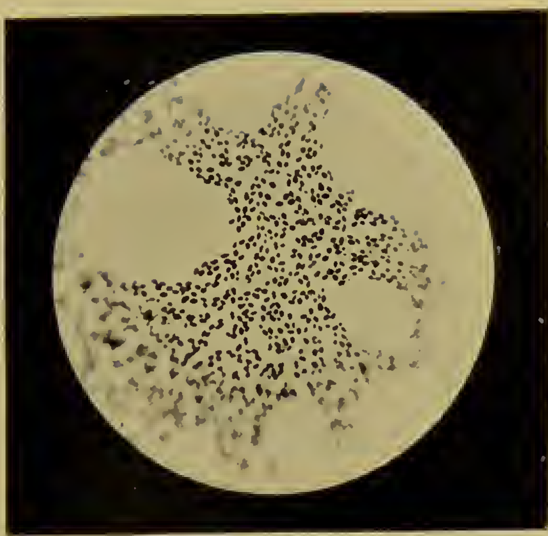
Bread when it has left the oven, and especially while it is still in the very moist condition, is an exceptionally good medium for the fixation of floating germs. Bread, however, being usually faintly acid, does not afford a suitable food for the sustenance of many of the bacteria, and consequently we find that the chief diseases of bread are fungi. There are one or two important exceptions which must be considered here.

Bleeding Bread.

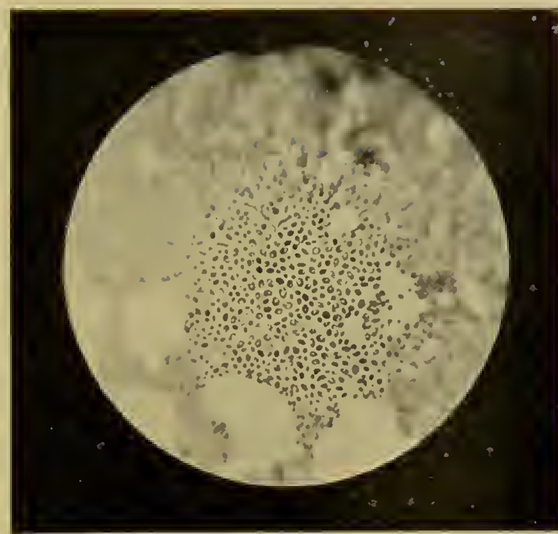
In late summer and early autumn bread which has been cut is sometimes noticed to become covered with tiny red spots like drops of blood. The disease, which is commoner in some districts than others, was in olden times called the Miracle of the Bleeding Host, the Bloody Sweat, &c., and it has certainly at times furnished condemnatory evidence in witchcraft cases. The researches of scientists have shown that these drops are the colonies of a bacterium. The organism has been named *Bacterium prodigiosum* by Ehrenberg. It grows well on moist potatoes, bread, and all starchy substances. It is a short bacterium, actively mobile in young cultures, and secretes a reddish colouring matter. It grows best at ordinary temperatures, and at blood heat produces no pigment. It is stated that the proteins of the bacterium are poisonous, so that bread infected with the growth had better not be eaten. The organism does not form spores, and it is therefore probable that the disease arises from exposure to air in which the germs are floating.

Rope.

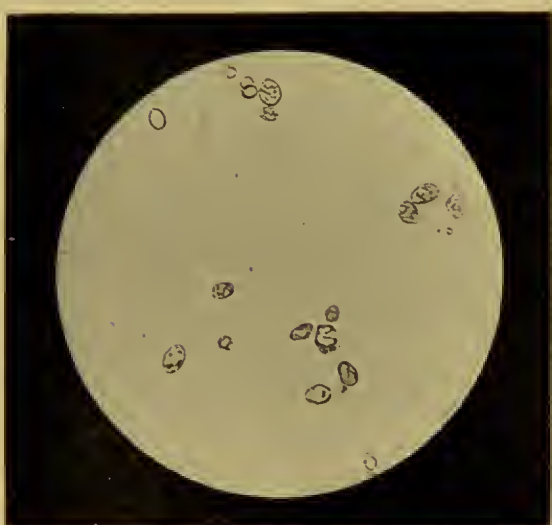
Rope.—This, perhaps, to the baker is the most important of bread diseases, because of the great loss it entails and the extreme difficulty experienced in eradicating it. The disease usually shows itself in bread during autumnal weather when the air is very moist. It appears about twelve hours after the loaf has left the oven, as small brown spots in the crumb, which gradually spread and become moist and slimy, so that the mass is pasty, as though saturated with syrup. The material can be drawn out in threads; hence the name rope. Bread attacked with the disease acquires an intensely disagreeable smell and is totally unfit for food. The temperatures at which the disease spreads most quickly are 25° to 40° C. (77° to 104° F.); at the same time moisture must be present. It has recently been shown by a series of careful experiments that this disease is due to a bacillus which is occasionally present in flour. The bacillus is a short sporing organism, which is commonly found in the soil; owing



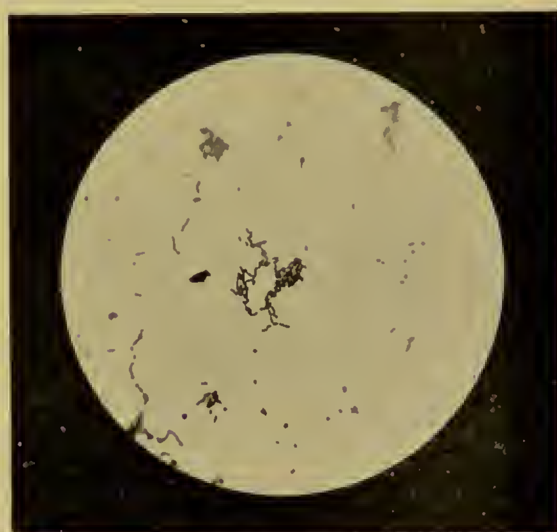
COMPRESSED YEAST



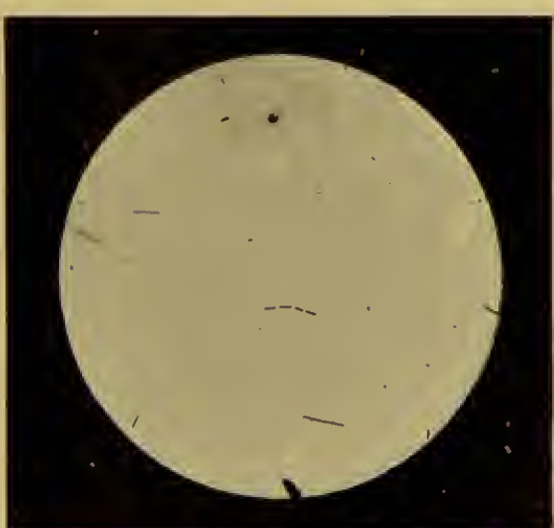
COMPRESSED YEAST (AFTER DRYING)



GROWING YEAST



ACETIC ACID GERMS



BUTYRIC ACID GERMS

LACTIC ACID GERMS

MICRO-PHOTOGRAPHS OF YEAST AND ACID-PRODUCING GERMS

to the frequency with which it attacks potato crops it has been called the Potato Bacillus, its bacteriological name being *Bacillus mesentericus* (Flügge). The bacillus attaches itself to the wheat skins, and in milling is detached and passes into the flour produced. The spores are extremely resistant to high temperatures; they withstand boiling for more than an hour, so that when present in flour they cannot be destroyed by baking.

Even when the bacillus is present in flour the disease does not always appear in the bread, for the conditions necessary to its development may not prevail. In addition to high temperature and moisture it is found that the bread must be neutral or nearly so. Now usually bread has a faintly acid reaction, which no doubt is sometimes sufficient to protect from the bacillus. That slight acidity will prevent the growth of the organism has been clearly shown by Watkins (*Journ. Soc. Chem. Ind.*, 1906, p. 350).

The disease called rope in cake is doubtless due to the same organism, and it has been asserted that in fruit cakes the disease does not appear, whilst plain cake made from the same flour becomes quite ropy. The explanation of this is to be found in the currants, which are markedly acid in reaction, and thus protect the cake made with them from the bacillus.

Moulds in Bread.

Flour is not sterile; on the contrary, it usually contains a large and varied assortment of bacteria, mould spores, &c. A series of experiments carried out by the writer with a high-grade patent flour very carefully cleaned, revealed the fact that 1 gm. of the flour contained some 30,400 bacterial organisms with 7 mould spores. Most of these organisms were common to air and water and would be killed at the temperature of the baking oven, and it is very doubtful whether the mould spores would escape destruction. The probability is that when moulds develop in bread it is from spores deposited upon cut surfaces from the air. The common moulds are green, brown, or black in colour. The colour is due to the spore-bearing heads, which differ in the various species. Each of these heads carries immense numbers of spores, which when ripe are distributed in a fine cloud into the air. These spores float upon water owing to fat contained in the cell wall, and therefore in all cases where it is desired to exterminate mould the only agent of real value is fire. All mouldy material should be burned, and dough troughs and other utensils should be well singed with a Bunsen flame.

The following are the common moulds: *Mucor mucedo* forms a white growth with dark-brown or black spore heads; *Penicillium glaucum* is the familiar sage-green mould so frequently found on stale bread; *Aspergillus niger* is a common black mould often attacking bread; *Oïdium aurantiacum* is the name given to the red bread fungus which produces an orange-red growth throughout the bread.

Moulds flourish on bread because of its faintly acid nature, and, as already noted, bacteria as a rule do not establish themselves, for the same reason, a faintly alkaline reaction suiting them best.

CHAPTER VI

THE COMPOSITION AND PROPERTIES OF FLOUR

We speak of flour as of poor or of good quality without attaching any definite meaning to either term. It is more correct to speak simply of the *character* of flour, making no comparison of its quality, since quality is generally determined by the method by which it is manipulated in making into bread. The character of flour is primarily dependent on the nature of the wheat from which it is made, then on the care exercised by the miller, then on the method of milling.

Character of Flour.

From whatever source flour comes its chemical composition varies within very narrow limits. It is not, in a chemical sense, a compound, but is a mixture of several compounds in varying proportions. Thus all flour contains *starch*, sometimes to the extent of 66 lb. in every 100 lb. of flour; and since starch is a dry substance consisting of multitudes of small round cells with no connecting substance between, therefore those flours above the normal in percentage of starch, are not by themselves good flours for bread-making, but make small close loaves.

Chemical Compounds in Flour.

Next to starch, in point of quantity in flour, is the *gluten*. Physically this is a tough, slightly elastic substance, either grey or yellowish-brown in colour. As it is insoluble in water and in the saliva of the mouth, it has no distinctive taste when washed from flour. When heated at a low temperature (about 212° to 260° F.) it softens and spreads out, gradually becoming tough, and ultimately dry and hard as the heat is continued. If subjected to a higher temperature (from 350° to 440° F.), it puffs up into a round ball, hard and brittle, owing to a skin or crust being formed on the outside; but, as the steam is generated by the heat within the piece of gluten, it expands the skin before the latter sets hard. When a piece of gluten is boiled in water, it does not appreciably expand but sets into a very tough but inelastic grey substance. This is similar to the condition of the gluten in the interior of a baked loaf, only that it is then set in fine threads or meshes, with the starch, &c., between. When gluten is carefully air-dried at a low temperature it becomes brittle and glossy like gelatine or glue, and may be ground into a fine powder. On being treated with water this powder has all the properties of gluten as originally washed from flour. It is in this way that gluten flour is made. When a piece of dough is fermented for some time and the gluten then washed out, this gluten will be found much paler than that from the same flour before being fermented.

Physical Properties of Gluten.

Condition of Gluten in Bread.

Chemically, gluten is a mixture of two (or more) very complicated compounds, both belonging to the series called *albumins* or *proteids*, of which white of egg is the most characteristic example. These compounds are called respectively *gliadin* and *glutenin*. Mann[1] gives the composition of wheat gluten as gliadin, mucidin,

Chemical Composition of Gluten.

[1] *Chemistry of Proteids*, p. 71.

glutin-fibrin, and glutin-casein, the last three really corresponding to what is otherwise called glutenin. There is not much known about the distinctive properties of these two substances, owing to the extreme difficulty in separating them in a condition of purity; nor is there much definitely known as to the manner in which they are combined to form gluten—whether the union is merely physical, in which case each substance would retain its own properties, and the properties of gluten would be the sum of those of the components, or whether the union is chemical, in which case the properties of gluten would be distinctive and persistent and different from the properties of its parts. Hitherto the former idea has been generally accepted.

Nature of Glutenin and Gliadin.

Glutenin is supposed to be an albuminoid substance that possesses stability, is not readily softened by water, nor dissolved by dilute alcohols. It is supposed to form the stable part of gluten. Glutenin is, however, soluble in dilute acids and alkalies. *Gliadin* is the compound which is credited with giving gluten its property of elasticity. It differs from glutenin in that it softens under the influence of distilled water, and dissolves when treated with dilute acids or alcohols. It has been suggested that, since glutenin and gliadin have such distinctive properties, and since the proportion in which these exist in gluten varies, the character of any gluten is due solely to the proportion in which these substances enter into its composition. This theory is simple and almost obvious, but doubts have been raised by some investigators as to its soundness. As, however, the tests on which the objections are based were in the nature of rough baking tests only, these objections cannot be accepted as establishing anything definite.

Soluble Proteids of Flour.

There is in flour proteid matter of another kind, usually called *soluble proteids.* This is composed also of several albumins of much the same chemical composition as gluten and white of egg, but with physical properties more like the latter. The albumins referred to are called *globulin, albumen,* and *protose.* These are soluble in water, and possess, amongst other properties, those of affecting the gluten of flour, and, to a slight extent, of changing soluble starch into sugar (see Chapter XIV).

Relation of Soluble and Insoluble Proteids.

That there is some intimate relation between the gluten (insoluble proteids) of flour and these soluble proteids there can be no doubt. Flour from wheat that has been sprouted contains a much larger proportion of the latter than the flour from sound wheat, and as there is no increase in the total quantity of proteid matter in the wheat when it starts growing, the soluble evidently increases at the expense of the insoluble. When there is a large quantity of soluble proteid matter in wheat the flour from it is invariably soft, owing either to the action of these proteids on gluten, or to that of the enzymes which are active during seed growth. On the other hand, when gluten in the course of fermentation of dough becomes partly soluble, it seems

Softening Action of Soluble Proteids and Acids on Gluten.

then to acquire properties not unlike those of the soluble proteids of the original flour. An alternative suggestion, to account for the softening action of a sponge on the gluten at dough stage, is that it is the result of the formation of a certain quantity of acid in the sponge. There may be in wheat, as it ages, or in flour under the same conditions, a gradual change from soluble to insoluble proteids, as there is, in the case of growing grain, from insoluble to soluble.

How Gluten Exists in Flour.

The question has been raised whether gluten, as such, is really present in the grain, or whether it is only formed at the time of wetting the flour to make dough; but the point is not of importance in a practical sense, as the gluten never fails to act when dough is made. The probability really is that gluten, as well as the soluble proteids, is in the form of impalpable powder mixed intimately with the starch cells.

Sugar in Flour.

In flour there is a quantity of natural *sugar* which has the composition and properties of cane sugar. It is this sugar on which the yeast in dough acts, and from which all the gas produced is obtained. The total quantity of sugar in flour varies considerably with the kind and grade, but is not above from 1 to 1·5 per cent of the total weight, or, roughly, from 2¾ to 4 lb. per sack of flour. If this were all fermented, and about half its weight produced in the form of gas, it would occupy a space at ordinary atmospheric pressure and temperature of about 15 cu. ft.; so that there is evidently sufficient gas capable of being formed to produce all the expansion of bulk in dough and in the loaves with which we are familiar. Experimentally, 10 gm. of sugar will produce about 82 cu. in. of gas when fermented with yeast.

Flavour of Bread not due to Sugar.

From the fact of sugar being sweet, it has been suggested that the flavour of bread is due to the sugar it contains; but if this were so, the bread fermented least, or not at all, would be the best-flavoured, and fermented bread would be deficient in flavour, since much of the sugar is entirely destroyed during the fermenting process. The facts, however, are quite the other way. Bread fermented insufficiently or not at all is nearly tasteless, whilst fermented bread has a pleasant, sweet, but by no means sugary flavour, which increases or improves up to a certain stage, and, past that, begins to decline, until ultimately it disappears, and other less pleasant flavours predominate. Since the flavour improves as the quantity of sugar diminishes, while a softening change is concurrently taking place in the gluten, the latter change has evidently a greater effect in producing flavour in bread than the sugar of the flour. Flavour is really produced by the blending of the flavours of the products resulting from fermentation.

Cause of Colour or Bloom on Bread.

Sugar has probably much to do with producing bloom or colour on the crust of loaves, since that disappears entirely when the whole of the sugar is fermented out of the dough. The condition of the gluten is, however, of importance here also, for dough that is over-ripe will not colour properly, even if sugar

has been mixed with it, and in dough that is unripe there is generally a rough reddish tinge about the crust not due to the presence of sugar.

According to some authorities there are, in flour, besides the substances already named, compounds akin to starch called *amyloids*. These are said to be of a highly viscous nature, and have been called vegetable gums. The quantity is given as from 2 to 3 per cent. Professor Hall, of Rothamsted, is the authority for this statement, but it is extremely doubtful if it would be borne out by analysis of roller-milled flours. In the filtrate from roller flour there is no trace of any substance giving starch reaction, nor anything akin to dextrin.

Amyloids in Flour.

Although flour seems an extremely dry substance, it always contains a greater or less quantity of water. There is no rule regulating the quantity, and it is not settled in what condition, or in what constituent, it is present, but as starch is a good absorbent of moisture, the water probably exists in flour principally within the starch cells, a hypothesis supported by the fact that soft flours generally contain a slightly higher proportion of both water and starch. The quantity of moisture in flour does not determine either the flour's strength or the amount of water it will require to make dough. The character of the gluten is the determining factor in both those cases. The starch of flour is so good an absorbent of water that when flour is kept for some time in a moist atmosphere it will actually gain in weight, while it will lose weight again if kept in a dry atmosphere. The water driven off in the latter circumstances is evidently, however, only the superficial moisture, and to drive it all off requires drying for a good many hours at a temperature of about 212° F.

Moisture in Flour.

Whether the water in flour has any influence upon its gluten has not been definitely determined; but it has been found that certain wheats yielding flour of a "runny" nature make much more stable flours when they have been washed, and when presumably some of the moisture has permeated to the flour, than when they have been cleaned and milled quite dry.

Influence of Moisture upon Gluten.

There is a small proportion of *fat* or *oil* in flour, a greater quantity in stone-milled than in that made on rollers, and more in the low grades of the latter than in the patent. In any grade of roller flour the proportion does not exceed 1 per cent, and in the patent grades it is a good deal less. When separated, the oil of flour is a pale-yellowish liquid without any taste or smell. In some discussions on flour-bleaching recently, M. Fleurent, a French chemist, attempted to show that the whitening effect on the flour is really due to the decolorization of its fat. The proofs, however, were far from convincing, and the probabilities are all against such a hypothesis. The slight colour of the oil, and the smallness of the quantity contained in such a large proportion of a solid powder like flour, can have no appreciable effect on the colour of flour in any case. An investigation by the writer into the effects of bleaching on flour showed rather that the gluten was the substance which

Fat in Flour.

had been changed in colour, generally from a yellowish tint to grey, while the starch was not in any way affected. Since gluten is present in nearly twelve times the proportion of the oil, and its colour is much more pronounced, whilst it exists in a state of division more suitable for mixing in a powder like flour and influencing its colour, the change in gluten explains the effect of bleaching better than a change in the fat.

Ash of Flour.

The mineral matter of flour consists principally of phosphates of calcium, magnesium, and potassium, with traces of the phosphate and sulphate of alumina. These have no appreciable effect on the fermentation of flour; but so far as they are soluble, they may serve to supply yeast with the mineral matter it requires for producing new yeast cells. The mineral matter also gives stability to the gluten, and renders it less liable to become soft and "runny".

CHAPTER VII

OLD AND NEW METHODS OF FLOUR-MAKING

Method of Grinding with Stones.

The very oldest method of pounding or bruising wheat between two stones, or with one stone in the hollow of another, is not much different from the method of grinding by stones in a proper mill. In both cases the bottom stone is stationary, and a rubbing or shearing movement of the top stone is the effective motion. In a stone mill the stones for grinding are circular, and are usually built up of pieces with iron bands round them. The bottom or bed stone is fixed, the top stone or runner is nicely balanced on an iron spindle, so that it may be raised or lowered, making the space between it and the bed stone as small or as wide as desired. Both stones are cut or corrugated in radial lines, so that when the top stone is running the wheat between it and the bed is sheared or scraped rather than bruised. The wheat to be ground enters by a hole in the centre of the runner, and is carried out towards the periphery, leaving the mill in the form of meal by an aperture round the outside of the bed. By raising or lowering the runner the meal can be made as coarse or as fine as desired.

General Effects of Stone Grinding.

The points about stone milling which have a special effect on the flour are: (1) that the grinding or pulverizing of the wheat is performed all at one operation, and that the only product is wheat meal, which contains all the constituents of the wheat mixed together; (2) that the grinding operation heats the meal. To obtain white flour from this meal it is sifted or bolted through sieves of varying mesh, the finest, which separates the fine flour, being made of strong silk. In grinding, the stones pulverize some of the outer parts of the wheat so small that they pass through the finest silks along with the white flour. These minute pieces of bran, germ, &c., are imperceptible individually, but

tend in the aggregate to make the white flour darker. As the inner coat of the bran and the germ of wheat possess, as already noticed, the property of slightly softening the gluten of flour, and as the germ particularly contains a good deal of oily matter, with at the same time an appreciable flavour, so flour containing these particles is much less stable, specially when newly ground, than roller flour, and it does not keep so well as the latter; but when new and sound it has a more pronounced sweet, or at least wheaty flavour. Some of this flavour is probably due, not so much to the presence of flavouring particles in the flour itself, as to the fact that when the meal was in a heated condition in the stones the essential oil or flavouring extract of germ was absorbed by the white flour then in contact, and was retained by the latter when the flavouring agents had been separated out; for flour is an excellent absorbent of flavours of all sorts that are volatile.

Colour and Flavour of Stone-milled Flour.

Reference has been made to the keeping qualities of stone-milled flour. When it is quite new it is comparatively soft, and if used for bread-making in this state it requires an extra quantity of salt. Its stability improves as it is kept, until when old it makes very tough dough that stands fermenting well; but as strength increases flavour declines, and old stone flour acquires a decidedly old taste, which in bad cases is like mustiness. It generally also becomes very lumpy. In days when all milling was done by stones and all transport was by sailing ships, American flour would not keep during the passage, although it was reputed to have better keeping properties than that milled in Britain, owing, it seems, to the practice which prevailed in America of cooling the meal as it came from the stones before bagging; whilst in British mills the meal was directly filled into sacks from the millstones. It should be noticed that the flour obtained from stones is necessarily all of one grade. The comparatively fine stuff separated from bran makes a sort of coarse flour of a brown colour and a sweet taste, which in old times was sometimes "redressed", sold as "dressed" seconds, and used as part of flour for cheap bread or for ship biscuit. Stone mills are not in much use now for flour-making, but are still required for whole meal and for grinding cattle feeding-stuffs. Recently, however, on account of the agitation of so-called food reformers, there has been a good deal of stone-milled flour used for special "farm house" bread, sold by bakers, strange to say, at more or less fancy prices.

Keeping Quality of Flour.

"Dressed" Seconds.

Roller milling is conducted on nearly the opposite principle from stone milling. Instead of grinding the whole wheat into meal, and then separating the fine from the coarse by sieves, the process is rather one of reduction, by which the central part of the berry, the endosperm, is separated in bulk, as it were, from the coarser and darker bran, &c., and only when the fine part is quite free from offal of all kinds is it made into flour. A roller mill consists of series of pairs of rolls, usually corrugated diagonally, and geared to run at different speeds. This gives a cutting or shearing action. The first

Roller Milling.

few pairs of rolls are called *break rolls*, because their purpose is to break up the wheat into small pellets. In this operation a certain amount of flour is made. This is called "*break*" *flour*, and is of a comparatively dark colour, owing to its being mixed with small particles of offal which cannot be separated.

"Break" Flour.

These particles, therefore, form part of the lower-grade flour. The bran may have a certain amount of fine flour adhering to it after it is separated. This is cleaned off in a machine for the purpose, and also forms part of the low-grade flour. The little pellets of endosperm, after being thus cleaned from everything that would tend to darken the flour, are called *semolina*, and in this state are ground into fine flour on smooth rolls. This flour may be granular, and is then said to be *high ground*, beeause the rolls are kept some distance apart; or it may be soft and smooth, if the rolls are kept very close together.

"High" and "Low" Ground Flour.

When roller milling was first introduced, the fashion was to make all flour granular, especially that containing a large proportion of hard, strong wheat. From the nature of the wheat, probably more than because of the method of milling, granular flour came to be regarded by bakers as very strong, but as flours from soft wheats came to be ground in the same way, granular flours lost their reputation for strength.

Granulation.

Now the fashion has quite changed, and even the strongest and hardest of wheats are low ground, and yield soft-feeling flours. Granular flours seem to take more time to hydrate in dough, and, accordingly, longer to ferment; but, exeept for this, granulation produces no appreciable result in the bread.

Low Ground Flour.

Roller-milled flour can be made in a single grade, containing the whole of the fine flour from the wheat, which may be 70 per eent of its total weight. In this case the flour is ealled *straight*.

"Straight Run."

On the other hand, it may be madc in two or even three grades. If there are two grades, they may be called *patent* and *baker's*, the former composing some 40 per cent of the total weight of wheat, the latter 30 per cent, making 70 per cent in all.

"Patent" Grade.

The term *baker's* is not applied beeause this grade is specially used by bakers, and on account of the false impression liable to be created by the name the term *clear* has been suggested as a substitute. If there is a third grade, the lowest may be cheap, dark, and poor.

Baker's Grade.

Within the last few years the terms *first patent* and *second patent*, commonly used at one time, have given place to the terms *short patent* and *long patent*, the former denoting the higher class and dearer flour, the latter the poorer and cheaper.

Short and Long Patents.

A flour composed of 50 or even 60 per cent of the total weight of wheat might be classed as a long patent, one composed of 30 to 40 per ccnt would be a short patent. Millers, however, are not very prccise in the manner in whieh they use the terms denoting their grades of flour, and what one miller calls a patent may not be anything like the quality of another miller's patent, so that to be told a flour is a patent gives no indication of its

character. There is no standard by which they can be judged, although competition amongst the large millers at home and in America has created a sort of unofficial standard, and, as each is endeavouring to surpass the others in quality, this standard has now become very high; but the flour is not sold according to grade, but under proprietary brands. Each of the large millers makes several grades of flour and sells them under different brands.

Standard Brand.

Besides the general system of grading already referred to, there are local systems which are more or less arbitrary. Thus in London the terms *Town Whites* and *Town Households* are used to designate the highest and second qualities of flour respectively, and *Country Whites* for the highest quality of flour made by country millers who sell in the London market. The term *whites* is in some cases synonymous with *patent*; in other cases it corresponds to a *straight*, minus the low grade from a very high-class mixture of wheat, or, in other words, what has been called a *long patent*. *Households* are generally *straight-run* flours from a cheaper wheat mixture than that used for *whites*. The writer appealed to a miller of authority in London as to whether there is any fixed rule by which London millers grade their flours, and the following interesting reply was received:—"There is no system whatever by which millers arrive at the grades of their flour, nor is any fixed method possible. We English millers get our supplies from all parts of the world, and the quality of the wheats varies so much that it reflects the greatest credit upon our technical knowledge and careful handling that the qualities of our flour vary so little. We have not only a multitude of sorts of wheat to deal with, varying continually in supply and commercial value, but in addition have to deal with variations caused by different climatic conditions year by year at harvest time. Under the circumstances a miller has to make the best use of whatever current conditions may be in the manufacture of the various grades. *Household* and *whites*, for instance, may sometimes be *straight-run* flour, sometimes they are not, and I do not think it possible to arrive at any rule beyond this, that the very highest qualities cannot be straight-run flours, for the best-quality wheat the world produces would not make *straight-run* flour of good enough quality. Several millers —London and provincial—make flour exclusively from the strongest wheats, and as we have good reasons for believing that our milling methods and technical knowledge are, to state the case mildly, not inferior to the Americans, bakers of a patriotic turn of mind should see what English millers can do for them as regards strong flour." It is evident from this that every miller is a law to himself in the matter of grading. In provincial districts the names used for the different grades of flour are different, but do not, except in their respective localities, convey any very clear indication of the values of the flour. Thus *Supers* and *Extra Supers* represent the

Local Systems of Grading.

London System of Grading.

Provincial Methods of Grading.

highest grades in some localities, while *Fines* is the name used for the lowest. In Somerset and the west of England the term *Toppings* is used for a kind of dressed seconds, which is still partly used in making what is called *Home-made* or *Farmhouse* bread. Here and there old-fashioned distinctions are still retained, such as *Red Tie, Blue Tie, Leather Tie,* &c., the distinguishing marks being twine of the colours named, or else a small tag of leather. Such distinctions are, of course, quite arbitrary. Millers who sell flour all over the kingdom distinguish their different grades by registered brands.

Roller-milled flour is, even when straight-grade, much whiter in colour than stone-milled, owing to the absence of dark particles of offal. But the very great improvement in colour of flour that has been effected since the advent of roller milling is not entirely due to this cause, but to the much greater care now exercised in thoroughly cleaning the wheat before it enters the mill at all. In the old days this particular operation, except for the removal of foreign grains and other matter, was not much regarded, but now washing and scouring occupy as important a position in the whole milling operation as the grinding and purifying of the products. The result is that even the low-grade flours, if somewhat dark, from the presence of particles of the darker portions of the grain, are still clean. The whitest roller flour from any grist is not necessarily the strongest, owing to the fact that, while gluten is distributed throughout the grain, it is supposed to exist in slightly greater proportion near the outside than at the centre, which is more starchy, and forms a goodly portion of the whiter highest-grade flour. It is on this account that a straight grade or a long patent, although both darker, may be a little stronger than a top patent. This rule, however, is not invariable.

Reasons for Whiteness of Roller Flour.

Relation of Colour and Strength.

The flavour of roller flour can hardly be called a flavour at all. This is very much due to the physical effect on the palate of the dry starch and insoluble gluten; but when the flour is fermented in bread, and when the gluten is rendered more or less soluble, it then readily mixes with the saliva and acquires a pleasant taste. It will generally be found that the high-grade flours have the most delicate flavour, the lower grades giving the sensation of coarseness. This effect is probably in great part a physical sensation, rather than a distinctive difference in taste. Nearly the same differences in flavour are noticeable in bread made from the same flour, if, in one case, it has been unripe in dough, while in the other case it is ripe enough. Other differences noticed in bread made from over-ripe dough are due to real differences in flavour, because of the accumulation of the products of yeast and other fermentations within the dough.

Flavour of Flour and Bread.

Unripe and Over-ripe Dough.

If kept in a cool dry atmosphere, there is hardly any limit to the keeping qualities of roller-milled flour. The higher grades contain nothing

liable to change. Unlike stone-milled flour, roller-milled flour does not present such a difference in working properties between new flour and old. All that age does is to bleach the flour slightly, and, if it has been kept in a dry place, to cause it to absorb more water at dough-making. If kept in a store badly ventilated, and under the constant pressure of bags piled up on it, flour will gradually deteriorate, becoming lumpy and sometimes sour, particularly if it has been stored new or in a damp state. But, under normal circumstances, flour keeps without any appreciable change in its general character for at least a year. Several explanations of the causes of gradual changes in flour have been offered, but they are all more or less in the nature of surmises, without direct proof. These changes have been ascribed to the action of the so-called *soluble ferments* or *enzymes*, which are supposed to exist in nearly all organic living substances like grain. These, it is suggested, produce a dissolution of, principally, the proteids, which re-form into other compounds, some of them of an acid nature. It has also been suggested that there is in all flour a quantity of ordinary acid-producing germs, such as lactic and acetic, and that these perform their characteristic actions very slowly in dry flour, gradually producing sourness. There is the third purely chemical theory, that proteids, being extremely complex compounds, are also unstable, and that they slowly break down and form new compounds less complex. The first or third of these suggestions may contain the proper explanation, such evidence as there is being against the intervention of organized acid ferments. Professor Hall recently stated that the acids in sound flour are not lactic and acetic, but a small quantity of acid potassium phosphate, which behaves both as acid and as alkali, according to the indicator selected. The presence of an acid substance of this nature may be quite normal, and not indicative of any change whatever in flour.

Keeping Qualities of Roller Flour.

Changes and Acidity of Flour.

CHAPTER VIII

THE CHARACTERS OF THE WORLD'S WHEATS AND FLOURS

British millers use wheat from nearly all parts of the world in producing their flour, and just as these wheats vary in character, so does the proportion of each used in any grist alter the character of the flour produced. To get at the reason, therefore, for the distinctive characters of flour, it is necessary to study the characters of wheats. For our purpose it is better to speak of wheat only in terms of the kind of flour that would be produced from it if milled alone. In practice there is not now much single-wheat flour made. As it will be necessary to use such terms as *hard* and *soft*, *strong* and *weak*, as applied to flour, it will be better to define exactly in what sense these terms are

Properties of Wheat in Grist.

employed. It has been suggested that *strength* should mean the property of making a bulky loaf, but as the bulkiness of the loaf is much more dependent on the mode of manipulation by the baker than on the properties of the flour, this does not answer all the requirements of a definition. But, since all admittedly strong flours require to be fermented for a much longer time than those that are soft to produce bulky bread, this property of resistance to fermentation, with a given quantity of yeast, may be accepted as the indication of strength. True, strength implies also *stability*, which means the property of keeping shape in dough without running flat. The strong flours show their gradations of weakening really in this direction of "runniness". The word *soft* as applied to flour is also subject to qualifications. Thus there is soft flour of a dead or putty-like character: it is quite stable, but is inelastic and non-resistent to the action of fermentation, and will make shapely but not bulky bread. Other flours, again, that are called soft are essentially "runny", will not resist fermentation, and will produce small and flat loaves. There are, of course, all degrees of strength and of weakness between these extremes.

Definitions of Hard, Soft, &c., Flour.

Stability of Flour.

Different Kinds of Softness.

Scotch Wheat Flour.

There can hardly be said to be such a thing as Scotch flour, but flour made from Scotch wheat is very soft, with a putty-like softness. It is quite unsuitable for making white bread of any bulk by itself, but may be used in goods raised by chemicals, or in water biscuits. The same wheat, however, makes excellent whole meal. In some districts in Scotland, notably in Haddingtonshire, an excellent flour for all sorts of biscuits, shortbread, &c., is prepared wholly from local wheat.

English Wheat Flour.

English wheat varies very much in character in different localities. The strongest varieties are those grown in Lincolnshire and some parts of Cambridgeshire, while Herefordshire grows soft sorts. Strength is not so much a desideratum with English farmers as a good yield and long straw, but if the strongest English wheats belong to soft sorts, they contain from 8 to 10 per cent of dry gluten, and in most cases have a tendency to be runny. Flour from this wheat is credited with a special flavour, but it is a debatable point whether this is due merely to the reputation which it gained in the old stone-mill days. In any case, there is nothing harsh about the gluten of this flour, and, mixed with stronger sorts, it makes excellent bread. Flour wholly from English wheat is not suitable for making the kind of bread people now like; it is, however, specially excellent for scone work and for cakes that do not contain a large quantity of fruit. Goods of this sort, made with English wheat flour, have and retain the very desirable softness which it is the aim of the baker or confectioner to produce.

Special Flavour of English Wheat Flour.

French flour, or at least the French flour with which we are familiar, is in character not unlike English. It is also much more suitable for

biscuit and hot-plate work than for bread. Imports of French flour to this country, except in the case of one or two brands which have nearly half a century's reputation for biscuit work, are not regular, but depend on the character rather than the quantity of the French harvest. On occasions when the home wheat is specially soft, owing to excessive rains or such conditions, the best flour French millers can make from it is too soft for the bakers, and in such circumstances the millers are allowed to import hard wheat duty-free, if they export an equivalent quantity of flour against it. They keep the product of the imported hard wheat for mixing for the local trade, and export an equivalent quantity of soft flour to us. It seldom contains more than 8 or 9 per cent of dry gluten. Since the equivalent as fixed by the Customs is really less than the hard wheat it represents would produce, the arrangement pays the French miller, and makes him willing to let us have the flour at less than its proper value rather than lose his market. The French flours we get are usually straight grade.

French Flour.

Now and again small quantities of flour are imported here from Germany and Belgium, and these are also rather soft, but still stronger than French. They are bread-making flours, that may serve for mixing, but as in Belgium particularly, a good deal of foreign wheat is imported, there is nothing characteristically national about these flours. They contain from 9 to 10 per cent of dry gluten.

Belgian and German Flour

Amongst continental flours in our markets the most important is that from Austria-Hungary. This is sometimes called by bakers Vienna flour, but the milling centre from which the bulk of it comes is Budapest. This flour varies in character, but it is the top grades that have made the reputation of the whole. It is not strong flour in the same sense that, say, Minneapolis flour is strong, yet it absorbs a large quantity of water, and requires a good deal of fermentation to mature it properly. It does not contain an excessive quantity of dry gluten, for, while some lots may have 11 per cent, the writer has had experience of several samples of excellent flour of this class with 9 or 10 per cent, and one lot as low as 6·7 per cent, yet even the last sample was excellent flour. Its gluten is not tough, but yellow and elastic, and belongs to the stable or even stogy class of glutens rather than to the "runny" sort. Hungarian flour does not by itself make large bread, but it usually produces a fine texture, a pleasant yellowish colour, and a bright sheen in the crumb of the loaf in which it is used, and a golden bloom on the crust. These characteristics are due as much probably to the extreme care exercised in milling, as to the character of the wheat, although the world acknowledges that there are no better wheats. On account of their reputation they have been used as seed wheats in some of the American states, notably Kansas, and in Australia and New Zealand, but the character seems to change after two or three years under different conditions of soil and climate. The top grades of Hungarian flour are always two or three shillings above the highest made in English mills,

Hungarian Flour.

Effects of Hungarian Flour in Bread.

and a good many bakers, who have a kind of religious faith in this flour, consider it impossible to make best bread without a proportion in their mixture. It is doubtful if they really get value for their money, for, although Hungarian is still excellent flour, British millers have made such strides in the skill with which they select wheats, and in the perfection of their processes, that some of their flours have all the qualities of Hungarian without its defects, and at a lower price.

English-milled and Hungarian Compared.

When British millers can obtain Australian wheat at a reasonable price they are always willing to compete for its possession. It yields a high percentage of flour of moderate strength and good colour and flavour. But a good deal of flour is now shipped from Australian mills direct. Its character depends much on the region from which it comes. The best variety for use by British bakers is that from South Australia, the port of shipment being Adelaide. This is the strongest native Australian flour. It is generally long-patent grade. It is white and strong enough to make bulky bread by itself, and contains from 9 to 11 per cent of dry gluten of a quality fairly stable. The supplies from Adelaide are steady in the seasons, owing to the fact that there are several mills at this port which have made a speciality of export trade. Victorian wheat and flour is of a milder nature than that of South Australia. Victorian flour is shipped at Geelong or Melbourne, and although these two ports are only some 40 miles apart, the flour differs considerably in strength and general properties. That from Geelong mills is as a rule stronger than that from Melbourne, because of the different sources from which the respective millers secure their wheat supplies. Victorian flour is inclined to be a little runny, yet, by proper treatment, it can be made to produce bulky bread of nice flavour and with good keeping properties. As with some other flours that have this tendency to soften much after being made into dough, best results are not obtained by making the dough stiff, but by keeping it moderately soft and kneading well. The flour received here from New South Wales was a few years ago stronger than other Australian, although the native wheat is actually weaker. The explanation of this seeming paradox is that Sydney millers, having virtually free ports for wheat, were in the habit of mixing some strong American with the soft native sorts, whereas in the other states, owing to high tariffs, millers had to depend wholly on native supplies. The equalization of duties under the Commonwealth Act, at the beginning of the present century, destroyed the advantage thus possessed by New South Wales. As a general rule Australian flours are stronger than those milled wholly from English wheats, but with something of the same mildness. In brightness and bloom, and in the subtle property we call flavour, they are not unlike Hungarian, while, under the influence of fermentation, they can best be compared with the hard winter wheat of Kansas. Australian flours contain from 9 to 11 per

Australian Wheat and Flour.

Adelaide Flour.

Melbourne Flour.

Sydney Flour.

General Character of Australian Flour.

cent of dry gluten. The imports to this country are not steady, but vary with the economic condition of the Commonwealth. Should the harvest be very large and prices for wheat rule low, then farmers are anxious to export as much wheat as possible, and millers to export as much flour, so as to reduce local supplies and raise prices in the home markets. This, and the need for immediate cash, which the banks will generally advance on bills of lading, causes a good deal of Australian flour to be sent to the English markets on consignment, and to be sold here at a price actually less than that obtained at its source.

Causes of Cheapness.

Canadian wheat is not all of one quality or character. That from the wheat-fields of Manitoba is extremely strong, belonging as a rule to the variety called *Hard Fife*. Flour made wholly from this class of wheat may contain as much as 15 per cent of dry gluten, of a tough and very stable character. This type of flour requires to be fermented for a considerable time, even apart from the quantity of yeast used, for the gluten seems to resist the softening action called "ripening", and to remain tough longer than any of the flours hitherto mentioned; but when the dough from this flour is well fermented, the bread produced will be very large and not deficient either in flavour or keeping qualities. Flour of this class is seldom used for bread-making by itself, but in a mixture with softer flours. Hard Canadian wheats now find their way in considerable quantities across the American frontier, and are milled by American millers and sent here as American flour. The product of the Canadian mills imported into our markets is not so strong as the characteristic American from Minneapolis. It is milled from milder mixtures of wheat, and is really more suitable for the short-system doughs which now obtain amongst the majority of our bakers. Our own millers use a large quantity of Canadian wheat, when supplies are within their reach, as the basis of strength in their flours.

Canadian Flour.

Amongst bakers Indian wheats have the bad reputation of making flour which seems strong, inasmuch as it takes much water to make dough, but gives or softens a great deal when it stands. Yet British millers, who certainly know their business, buy this class of wheat in large quantity. The fact is that there are many varieties of Indian wheats, but two distinctive sorts are principally used by British millers. One sort, generally called *Kurrachee*, is moderately strong, and, although its flour is inclined to soften a little in dough, it has some compensation in giving a high yield. The writer has had the opportunity on several occasions of carefully testing flour milled solely from this type of wheat, and there was no difficulty in producing a moderate-sized loaf from it. The greatest defects in the loaf were a certain harshness of crumb and absence of flavour, and a roughness and want of bloom on the crust, which modifications in the process of fermentation seemed incapable of removing. The other variety of Indian wheat largely used by our millers is sold as *Calcutta*, and in several grades. This wheat is much less stable than the

Indian Wheat Flour.

Kurrachee Wheat.

Calcutta Wheat.

other, and in flour by itself makes very flat bread, with a harsh crumb and either a brittle or a tough crust, aeeording to the state of the dough. These wheats are, of eourse, used by our millers solely on aeeount of their eheapness. They are not really deteriorating faetors, so long as suffieient wheat of a stable eharaeter is also used in the mixture. The only danger is that, in the stress of eompetition, there may be a tendeney to inerease gradually the proportion of this elass of wheat in the grist, in the hope that

Bakers' Troubles witn Indian Wheat Flours.

the baker will not know; but when the latter finds his dough soft and stieky when it should be tough and stable, and his loaves when proving beeoming flat instead of standing up boldly, then he knows there is something wrong with his flour. As Indian is one of the good elass wheats which possesses this tendeney in its flour to runniness in the most pronouneed degree, this may be a favourable point at whieh to note that, while this defect is evidently in the gluten of the flour, there is no knowledge yet available as to the cause, but it is eharaeteristie of the glutens of several other wheats. The miller's eomplaint against Indian wheat is the large quantity of dirt mixed with it, but as it is the speeial eare of our millers to remove this dirt entirely it in no way influenees the eharaeter of the flour.

Of foreign wheats, that most largely used by our home millers is from South Russia. This is strong wheat, and being more moderate in priee

Russian Wheat and Flour.

than wheat of the same charaeter from Ameriea, it supplies a very suitable basis of strength in our flours. Very little Russian flour is now imported into this eountry, but some years ago the quantity shipped from Odessa was considerable. This, whieh contained nothing but Russian wheat, was patent-grade flour eontaining from 10 to 12 per eent of dry gluten. It was strong flour, in the sense that it required to be well fermented to ripen, but it also showed a tendeney to soften very mueh after making into dough. This flour was not harsh and hard in working, but produeed bread of very niee flavour. A eommon defeet was that it was not infrequently tainted with the odour of tar, evidently from eontaet on shipboard. Russian wheat as used by our millers sometimes produees flour with a tendeney to runniness, and in this ease the explanation has been offered that it is caused by a small proportion of

Effects of Rye in Wheat Flour.

rye grains being mixed with the wheat. These rye grains are extremely diffieult to separate from the wheat by the ordinary maehines. The proteids of rye, or what stands for its gluten, have an exeessive degrading or softening aetion on the gluten of wheat flour. This may be a satisfaetory explanation of the softness of Russian wheat flour in some eases, but there is probably some other physical or ehemieal eause, inherent in the gluten itself, whieh has not yet been diseovered. In the seasons 1904–5, when Ameriean and other hard wheats were so searee, our millers had to rely almost exelusively on Russian for strength, and bakers will remember how diffieult it was to obtain flour with the necessary stability to produee bold erusty bread.

When Russian wheat is searee and dear, resort is had to Argentine as

a substitute. This also is a comparatively strong wheat—not so strong as Russian or Minnesota, but a passable substitute.

Argentine Wheat and Flour.

There is a small supply at intermittent intervals of flour from Argentina, but this is not of very high class, owing perhaps rather to careless milling than to the quality of wheat used. It lacks stability, and can be used in bread-making only along with stronger flour.

American Wheat and Flour.

American wheats as used by our millers are either of the very hard sorts from Minnesota and Dakota, or the weak white wheats from the Western States. The first of these is used for strength, the latter principally for colour. Of all foreign flours bakers are most familiar with American, because it has been longest in our markets as the direct competitor of our home-milled flour. At one time, up to some thirty years ago, the bulk of this flour was brought here in barrels, each barrel containing 180 lb.; but on account of the numerous breakages, the difficulty in handling, the cost of the barrels themselves, and the excessive space in proportion to weight they occupied in ships' holds, the use of barrels has almost ceased, except small quantities used for supplying ships' stores, and jute and cotton bags, generally 140-lb. sizes, have taken their place.

Minnesota Flours.

The American flour best known in England, and in fact all over the United Kingdom, is that from very hard wheats milled in Minneapolis district. This is without exception the strongest flour in our market—is, in fact, too strong for use by itself in making bread, except when the proeess is a long one with sponge and dough. This class of flour is generally spoken of as being made from single wheats, but it is more correct to speak of it as being from wheats of single type.

Early American Roller Flours.

When these hard flours first reached our markets as roller-mill products, they were much stronger than at present. The patents were shorter than they are now, whilst the second and lower grades were much stronger. At that time some of those flours contained as much as 16 per cent of dry gluten, and that of extreme stability. As a rule, this flour now contains from 11 to 13 per cent, but much less tough than formerly. This change has been brought about, probably to suit the requirements of the British market, by the millers using some softer varieties of wheats in their mixture. As already noticed in connection with Canadian, this kind of flour resists the softening agents that are present in fermenting dough, and it requires to be very well fermented before it loses the excessive toughness and harshness which is characteristic, and acquires the elasticity and softness necessary to produce nice bread. But if this kind of flour is properly ripened in dough, it produces very bulky bread.

Strong Flours in Scotch Bread.

It is not usual, even in those places where long processes are adopted, to use this type of flour by itself; although in Scotland it forms, either as American-milled flour, or as the product of Scottish mills from the same kind of wheat, the greater portion of the mixture for batch bread. In America, where it is very largely used alone, its extreme hardness and tough-

ness are tempered by the addition of fat in one or another form in the bread.

Within the last twenty years or so there has been a gradually increasing quantity of flour imported here from the state of Kansas. This belongs also to the strong-flour class, but with the same kind of strength as Russian rather than with that of Minnesota. The patent grades of this flour may have from 10 to 13 per cent of dry gluten, but of a kind rather unstable. The dough made from Kansas flour, even if doughed quite stiff, softens quickly as fermentation proceeds, and has a tendency to be slightly runny. Yet, in spite of this, the flour requires to be well fermented to bring out its excellences, and better results are obtained with rather slack than with tight doughs. The flour of this type imported varies a good deal in character, some being quite stable, other lots very soft and runny. Flour from the adjoining state of Nebraska is of much the same nature as Kansas, but if anything a little softer.

Kansas Flour.

From Illinois we receive a good deal of soft winter-wheat flour. This is essentially a biscuit and cake flour, although as part of the batch mixture along with stronger sorts it produces beautiful bread, soft and silky in crumb, and with a good flavour. This flour contains from 8 to 10 per cent of dry gluten. It is not used in very large quantity in England, but in Scotland and Ireland it is the favourite for all sorts of goods aerated with chemicals, and for those baked on hot plates, as well as for hand-made biscuits.

Illinois Flour.

The softest varieties of flour which we receive from America are those from Ohio and neighbouring states. These are very white and soft, with a softness like putty. They are not suitable for bread by themselves, although quite stable, for the bread baked from such flour alone would be very small and close, probably with large cracks on the side of the crust. Where girdle scones are made at home this kind of flour is very suitable, as it is also for boiled puddings. In Scotland it finds much favour amongst grocers because of its whiteness and cheapness, and because it is suitable for the purposes required by their customers. Flour of this class may contain from 7 to 9 per cent of dry gluten.

Ohio Flour.

British-milled flour,[1] as already indicated, is always made from a mixture of wheats, the flour itself being designed to suit local rather than universal requirements. This was particularly the case some twelve or fourteen years ago, when millers, as a rule, were content with a local reputation and a trade within easy reach of their mills. There have since sprung up several proprietary and company concerns on a very large scale, which undertake to supply bakers in any part of the United Kingdom. As the flour from these mills has, in general competition, taken the place

British-milled Flour.

[1] It may be interesting to note here that the use of foreign wheats by British millers is not a new custom nor one resulting only from free trade. In an old work on Bread-making, published in Glasgow in 1830, the following are given as the sources from which a good deal of the wheat supplies were obtained: Poland, Prussia, Russia, Germany, Zealand, Coast of Barbary, Black Sea Shores, North America, Spain.

of top-grade American without wholly or even considerably supplanting that of local millers, the tendency amongst all the large port millers referred to is to make a strong flour, which contains from 10·5 to 11·5 per cent of dry gluten. As these mills compete with one another, the strength of all of them tends to uniformity. Of four or five of the flours from such sources with which the writer is acquainted, it is quite possible to distinguish between one flour and another by certain characters which each has. One such flour has a creamy yellow tinge and is mild in its manner of working, but yet stable and strong; another flour is slightly stronger, but is harsher and tougher and produces a larger loaf, but not with the same silky texture as the other. One of the flours with a good reputation and a large sale is softer than the two already alluded to, but is of very white colour, and just strong enough to make a fair-sized crusty loaf by itself, but it is more suitable for tin bread. There seemed to be a danger at one time that these large milling concerns would quite crush out the smaller mills, but, by improving their processes and by adopting efficient machinery, the latter have not only saved their position, but in very many cases bettered it; and it is now quite a common experience to find that the flour from a small local mill is better in all respects, from the baker's point of view, than that from the large port mills, and lower in price. In districts where wheat is still grown the inland millers more readily obtain supplies, and the presence of this English wheat in their grists is not without influence in giving to their flour that mildness which bakers desire. Some of the best flour is still made in small mills. Considering the difficulties of wheat supply, the quality and uniformity of the British-milled flours are remarkable, and on this account many bakers, who a few years ago used a large proportion of American patents in their bread mixtures, now use none.

Large Millers Supplant American Flour.

Distinguishing Character of Special Flours.

Salvation of the Small Mills.

CHAPTER IX

THE BLEACHING OF FLOUR

Patent or highest grade flour is, compared with other grades, the whitest and also the dearest, and anything that the miller can do to transfer some flour from the lower-priced second grade to the higher grade, without appearing to reduce the quality of the latter, looks like an advantage to him. As colour is the rough test by which bakers judge of the grade of flour, so the temptation to whiten his flour is very strong on the miller. Within some three or four years various patents have been taken out for whitening flour by chemical means. The flour, *after it is made in the usual way*, is mechanically mixed for a few minutes with gases, which have the effect of removing its

Possible Changes of Grade by Bleaching.

yellow colour and increasing the appearance of whiteness. The exact composition of these gases has not been accurately determined, but there are several that can effect the purpose without injuring the flour in smell or flavour. Those that have been adopted on a commercial scale for this purpose are oxygen in the very active form of ozone, and the several oxides of nitrogen, principally peroxide of nitrogen (NO_2). These gases may be prepared in the usual chemical way, or by the action of an electric discharge on the gases (oxygen and nitrogen) which compose the atmosphere; but however the bleaching gases are produced, their general effect on the flour is the same. The mechanical part of the bleaching process is simple enough. The flour, after being milled and purified, is carried through a cylinder by means of a "conveyor", which has an opening out or separating action, as well as that of pushing the flour along. The cylinder is fixed in a horizontal or slightly inclined position. While the flour is being conveyed through this machine, the gases already mentioned are thoroughly mixed with it. The flour and bleaching gases are in contact for only one or two minutes, and the supply of gas is regulated by a stopcock, according to the amount of bleaching wanted—a greater supply for a full bleach, a smaller quantity for mild effect. Exactly the same effects can be produced without any machine, by simply shaking some of the bleaching gas with flour in a wide-mouthed bottle. Except whitening it, the process does not produce any effect on the flour pronounced enough to be distinguished by ordinary observation; there is no special smell, nor any difference in taste as compared with the same flour unbleached. In the case of flour treated with ozone, there is a characteristic odour due to impurities in the gas, but this soon disappears.

Bleaching Gases.

Mechanical Part of Bleaching.

The patentees of bleaching processes are not content to claim only that the flour is whitened, but assert that it is improved in somewhat the same way as by ageing; that it increases the yield of bread by causing the flour to absorb more water. On the other hand, the inducement held out to the miller to use the process is that it makes best flour from wheats not otherwise suitable for that purpose; and that from any given grist it will make a long patent as good flour as a short patent in the ordinary way. This latter contention is not intended for the baker; it means that the miller can sell him a flour at a price above its value without his knowing it. But a claim of this kind errs in not taking note of all that goes to make up the characters of different flours, or of different grades of flour. There is a good deal more difference between the grades of flour than mere colour, and the baker soon realizes that something is wrong, even if he cannot quite tell what it is, when he uses a second-grade product and compares it with the results obtained when using a patent.

Claims for Bleaching.

Bakers' Suspicions of Bleaching.

Chemical and Other Changes in Bleached Flour.

There is undoubtedly a slight chemical change in flour that has been bleached, but as the process is not in commercial operations carried to extremes, ordinary chemical

methods of investigation do not readily discover what that change is. Some authorities suggest that the process is one of nitration; that one or other component of the flour actually receives an augmentation of nitrogen from the bleaching gases when these are oxides of nitrogen. Others contend that the bleaching is a process of true oxidation; that the substance bleached in the flour has a greater affinity for the oxygen in the oxide of nitrogen gas than the nitrogen with which it was previously combined, and so the transfer takes place. One French chemist, M. Fleurent, considers that the bleaching is merely the result of the oil of the flour being changed from a pale yellow to a nearly colourless substance. Considering how small an influence the colour of the fat in flour can have on the whole material, since the flour is a powder and not a substance through which fat or oil can be uniformly diffused as it might through a liquid, and considering that a patent grade of flour may not contain more than ·5 to 1 per cent of fat, this explanation of the effects of bleaching seems unsatisfactory. But since the substance in flour which has the greatest influence in affecting its colour is the gluten, and as this and not the starch is the constituent really changed in colour by bleaching, the change in colour of the whole flour may be ascribed to the effects of the bleaching gases on its gluten. Bleaching does not make crude gluten as washed from flour whiter, but actually makes it darker. It changes the tinge really from yellowish or brownish to quite grey, which in very extreme cases of bleaching may appear quite black. The whitening effect on the flour due to this change in colour of the gluten is optically the same sort as that produced when a small quantity of blue is added to a yellowish-white substance to whiten it. There is no change whatever in the colour of the pure starch of flour when bleached. The colour of bleached flour is chalky white. In bread it produces a crumb with the same characteristic whiteness as the flour, and the crust of the loaf inclines to be dull and greyish rather than bright yellowish-brown. The advocates of bleaching plead that its justification is the demand of the public for very white bread; but while the public do prefer white in preference to dark bread, there is no evidence that it raises any objection to bread with a creamy-white tint, or even that it does not prefer this tint to a chalky white. It is important to notice that bleaching does not make low-grade flours white, but changes them from brownish to dirty grey, so that it is not useful in supplying the public demand for whiter bread in the case of those who can only afford dark bread; while amongst those who can afford the best, there is no demand for greater whiteness.

Theories of Bleaching.

Changes in Colour of Gluten.

Effects on Bread of Bleached Flour.

Bleaching Low Grades.

It has been stated that bleaching not only whitens flour, but also dries and sterilizes it. The supposed drying process is not due to the heat of the bleaching gases, for there is a special arrangement for cooling these before use, but is supposed to be due to the gases in some way utilizing the moisture of the flour in the chemical

Supposed Sterilizing Effects of Bleaching.

reaction that actually occurs. It is evident, however, that the abstraction or utilizing of the moisture of the flour during bleaching, and the use of an extra quantity of water afterwards to make dough, would be no actual gain, as the increase in relative weight at dough would only compensate for decrease in weight of flour after bleaching. This contention assumes that the process does really dry the flour; but as the result of many experiments the present writer has not found that there is any difference in the quantity of moisture in bleached and in unbleached flour, nor in the amount of water required to make a dough. Such difference as there is rather points to the dough from the bleached flour being softer and less stable than that which the same quantity of water and unbleached flour would make.

There is really more than a suspicion that, with regard to both moisture and sterilizing, the supposed effects on flour are deduced wholly from theoretical considerations which do not fit the facts of the case.

Does Flour Require to be Sterilized?

There is no proof that flour, especially the higher grades, contains disease or foreign germs in any appreciable quantity, or that those present produce serious changes in flour as kept under normal conditions. In any case, there is no difficulty in keeping flour sweet and almost without change for a long period, so that, apart from the fact that it would require a period of one or two years to demonstrate the different keeping qualities of bleached and unbleached flours, there seems to be no sufficient reason for sterilizing flour at all, even if it could be easily done without affecting it otherwise.

Proof of Keeping Qualities Difficult.

If the proof of the sterilizing effects of bleaching is to depend on resistance to mould in the loaf produced from it, then it has only to be pointed out that the germs of mould are not necessarily, not probably, present in the flour at all, but may be introduced from many other sources, either while the loaf is in the dough stage, or afterwards while in bread. If it is suggested that bleaching sterilizes flour so that it resists the action of germs afterwards, then this property would be more harmful than beneficial.

Possible Danger of Sterilizing.

Not only does yeast ferment some of the soluble matter of flour, but there are other germs, as well as enzymes, which are essential factors in bread fermentation, and anything likely to harden the flour against their respective actions is not, or at least may not be, an improvement.

It has already been noticed that bleaching, as performed commercially, is not allowed to proceed to an excessive degree. The colour is only slightly changed, and, physically and chemically there is not much difference between the bleached and the unbleached flours; so small a difference, in fact, as not to be distinguished in ordinary bakehouse methods.

Commercial Bleaching Moderate.

To discover the effects of bleaching, it is therefore necessary to take a case in which the process has been carried to the full but not really excessive extent, to note the effect, and to deduce from the results obtained the probable lesser effects following less action of the gas. A series of experiments conducted in these circumstances with

care showed that while the bleached flour fermented quicker and the dough was ripe sooner than the unbleached, the former was sticky and unstable as compared with the latter. In washing glutens from the respective flours the quantities obtained were as follows:—

Effects on Fermentation.

Tests on Gluten of Bleached and Unbleached Flour.

	Bleached.		Unbleached.
	10·25 per cent.	......	10·6 per cent.
	9·65 „	......	10·85 „
	10·75 „	......	10·95 „
	11·1 „	......	11·45 „
	9·75 „	......	10·4 „
Average,	10·3 „	......	10·85 „

Although these results vary in individual cases, the quantity of dry gluten is in each case greater in the unbleached sample than in the bleached, and the averages, which are taken from enough samples practically to eliminate the errors of experiment, show that the difference is appreciable. This would seem to indicate that bleaching reduces the quantity of insoluble proteids (gluten) in flour, which is not inconsistent with even an increase in total nitrogen, as suggested by some chemists, but would merely indicate that the oxides of nitrogen had changed some of the proteids from the insoluble to the soluble state; and, as bakers know, this change, prior to the fermenting process, is not favourable to strength and stability in the flour, and is more likely to produce dough that is soft, or even runny, and that will not bear overmuch fermentation. This last point was demonstrated in a positive way by means of small ferments in graduated cylinders. The stability of the flour is measured by the height to which the ferment rises in the cylinder before it breaks. The following were the results obtained in three cases:—

Stability Tests on Bleached Flour.

	Bleached.		Unbleached.
	240 c.c.	......	263 c.c.
	245 „	......	263 „
	238 „	......	260 „
Average,	241 „	......	262 „

The bleached flours were less able to withstand the action of the yeast, &c., in the ferments, and dropped sooner, although in each case both sorts of flour were kept under exactly the same conditions of temperature, &c. These results are unfavourable to bleaching, from the baker's point of view, and show that it deteriorates the quality of flour in several respects for bread-making purposes. The trouble likely to beset the baker is that owing to varying degrees of treatment on the flour it may be affected for the worse while the cause may not be very apparent. The process has been already extensively adopted both in this country and in America, but it may be only a passing expedient, as it is quite certain that the best flour does not need it, and is not improved by

being treated, while the change effected on lower grades does not improve them as flour for bakers' purposes.

CHAPTER X

THE MIXING AND BLENDING OF FLOUR

It is the common experience of all bakers that flours vary with regard to the time they require to ripen in dough. For this reason very strong or hard flours are invariably used in sponge when the sponge and dough system is followed. On the strength of this, the idea has somehow been adopted by bakers that in a mixture of hard and soft flours each kind retains its individual character in spite of the proximity of the other sorts, and that, while the softer flours ripen first, the hard remain unripe, or at least ripen more slowly. There is no evidence in practice in favour of such a view, and even on theoretical considerations it is hardly tenable. Assuming that gluten is present in flour as an impalpable powder, then as that of the soft flour mixes with that of the hard, the one modifies the character of the other, and the mixture when wetted has properties unlike either of its components, but has really become a true blend of the two. It is not necessary to assume that the glutens blend chemically and form a new compound. The supposition that the physical characters of each are modified by those of the other is quite sufficient to account for all the observed facts in connection with flour-blending. But while mixed flours ferment with uniformity throughout, if thoroughly mixed in the dry state, the same flours made into dough without previous mixing are likely to ferment with varying intensity in different parts, and to seem more or less patchy. On this account flour made up of several kinds should always be well mixed dry. In the absence of any other mixing apparatus this can be done by the arms, if the work is done by hand; or if dough is made by machine, then a few turns before adding any liquor will effectively blend the flours.

Glutens in Mixed Flours.

Practical Experience of Flour Mixtures.

Effects following Bad Mixing.

The point is often discussed whether flours ought to be mixed together for some time before use. If flours are very much alike in character, there is no great advantage so far as their properties are concerned, but if they are widely different in character—one or more very soft and the others hard—then it is better that they should be mixed a few days before use. For this purpose there are in some bakeries large bins of a capacity of fifty or sixty sacks of flour. The flour is sifted into these and mixed, and is drawn off into the doughing machine as required, the latter generally having an automatic weigher fixed above it, so as to weigh accurately and register the amount for each batch. Where no

Should Flours be Mixed some Time before Use?

Storing and Mixing Bins.

bins are in use the general practice is to blend the flour and re-sack the mixture in convenient weights for use. This plan is convenient and economical, but to secure uniformity of the mixture either a mixing bin is required or a blending machine, in which the proportion of each kind in a sack of the mixture can be accurately measured. Where space is a consideration, this is about the most convenient system of blending that can be adopted. Sifting prior to blending is an aid to the closer and better admixture of the flour particles, and should be done where possible. It seems necessary that in any case sifting or re-sifting should always immediately precede dough-making. However careful people may be, there are occasions when foreign matter, more or less objectionable, does get into the flour, such as pieces of string, fluff off the bags, or, on occasions, even a dried mouse. Of course, such things should on no account be allowed to get into the bread. These sifting and blending operations take time and labour, but are well repaid by the improvement and uniformity of results.

Blending without Special Bins.

CHAPTER XI

THE TESTING AND JUDGING OF FLOUR

The colour of flour is not by itself a safe indicator of its quality, and, since bleaching has been adopted by millers, it is less so than ever: but as good colour is generally collateral with high grade, an estimate of colour is the easiest method of judging flour in a rough way. One great drawback is that there are no quite satisfactory standards with which the various grades of colour can be compared and the gradations of shades recorded in figures. The best recording instrument of this kind is *Lovibond's tintometer*, but, besides being an expensive instrument, the comparisons between flour and the tinted slips of the apparatus are not quite defined, owing to the difficulty of artificially obtaining the subtle something about the colour of flour we call bloom. This bloom is best seen when the flour is placed in a little loose heap. The usual method of testing flour for colour is to press it flat on a piece of cardboard or wood. For pressing, a piece of plate glass is a convenient instrument. As two or three flours are usually compared at once, a small quantity of each is placed on the board in a long strip and gently pressed flat with the ivory flour-tester or "slick", then each lot pushed close to its neighbour so as to show no division between the different kinds. The whole are then altogether pressed evenly with the piece of glass, the pressure being downward and forward. The relative colours of the flours are very well seen by this method, but its correctness depends on the slips of flour being all thick enough not to be

Colour as Indicator of Quality.

Bloom of Flour.

Conditions Altering Relative Colours.

transparent, on their being as nearly as possible all the same size, on the line dividing them being not too pronounced, and on the nature of the light in which they are looked at. Direct sunlight is not suitable, and it is necessary to look at the flours from two or three directions to be quite certain that the differences in colour are real.

Pekar's Test.

What is called Pekar's Test consists simply in taking the piece of wood with the strips of flour on it and gently dipping it, in a slanting direction, into some clean cold water. The surface of the flour is wetted, and while in this state, any dark specks which might not be visible when the flour is dry are readily seen. The wetted flour is then allowed to dry and is examined again. The colour

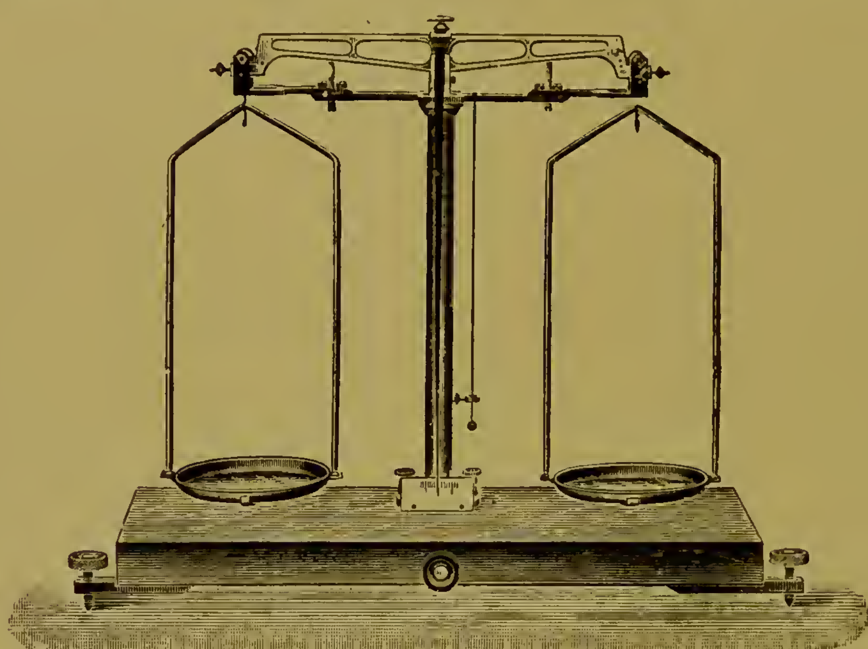


Fig. 1.—Chemical Balance.

of the dried surface is supposed to correspond very nearly to the colour of the bread which the respective flours would produce. Pekar's test for colour does at least show slight differences which could not be distinguished by the dry method.

Crude Gluten.

The next and probably the most important operation in flour-testing, is to find the quantity of gluten contained in the flour. Gluten is insoluble in cold water, and can be readily obtained from a piece of dough by washing out the starch and soluble matters, leaving the crude gluten as a tough, yellowish-grey mass in the hand. Besides gluten proper, this tough substance contains the greater part of the oil of the flour, and unless very well washed also contains a small quantity of starch.

If the exact proportion of crude gluten is to be ascertained, the flour must first be carefully weighed on a chemical balance (fig. 1). A convenient quantity to take for the purpose is 20 gm. of flour. This is placed

FORMER PRESIDENTS, SCOTTISH ASSOCIATION OF MASTER BAKERS

William Curr, of Paisley, was born at Stonehouse, Lanarkshire, in 1853. He is a trained baker who has raised himself to his present position by energy and skill. He takes a great deal of interest in all trade concerns, and amongst other things is an ardent bowler. He was appointed President of the Scottish Association of Master Bakers in 1906.

John Brown, born at Kilmarnock in 1845, after serving an apprenticeship, worked as journeyman and as foreman, until he started on his own account in Kilmarnock in 1881. He was amongst the first in Scotland to use and to advocate compressed yeast in ordinary Scotch batch bread. He has taken a special interest in the work of technical education, and in all Association work in connection with the trade in Ayrshire. He was appointed President of the Scottish Association of Master Bakers in 1905.

David D. Martin, J.P., was born, the son of a master baker, in East Calder, Midlothian, in 1853. He started a new business in Harthill, Linlithgow, but moved in 1878 to Edinburgh, where he now does a large wholesale trade amongst grocers. He is a member of both the National and the Scottish Association of Master Bakers. He was early on the Executive of the latter, and was elected President in 1904. Mr. Martin takes an active interest in public affairs, and was elected on the Town Council in 1899, and created a Justice of the Peace in 1900.

John Gibb, Dunbar, was born at Duns in Berwickshire in 1835. He was apprenticed to his father as a baker, and started on his own account near Edinburgh, but in 1863 moved to Dunbar. He entered the Town Council in 1886, was Burgh Treasurer, then Bailie, and ultimately Provost in 1899, holding the latter office for six years. He is also a member of the Parish Council and the School Board. Mr. Gibb was President of the Scottish Association of Master Bakers in 1902.

WILLIAM CURR
(Paisley)

JOHN BROWN
(Kilmarnock)

D. D. MARTIN, J.P.
(Edinburgh)

JOHN GIBB
(Dunbar)

FORMER PRESIDENTS, SCOTTISH ASSOCIATION OF MASTER BAKERS

in a small shallow porcelain basin, about 4 in. diameter, and about 10 c.c. of water (weighing roughly 10 gm.) run on to it from a graduated burette. This flour and water are then made into dough, the mixing being done with a piece of stout glass rod or sealed tube, or with a stiff bone or horn spatula. The mixing must be done thoroughly, without the flour being touched by hand. When thoroughly mixed the dough should be about the stiffness of that for English cottage bread. This dough is transferred to the balance, care being taken to clean every particle from the basin in which it has been made (a small artists' palette is a suitable instrument for this purpose), and weighed. The object of weighing the dough is to ascertain how much water has been used in making it; for although the quantity was measured from a burette, there is some difficulty in reading this quite accurately, and as it is from the quantity of water that is

Estimate of Water in Dough.

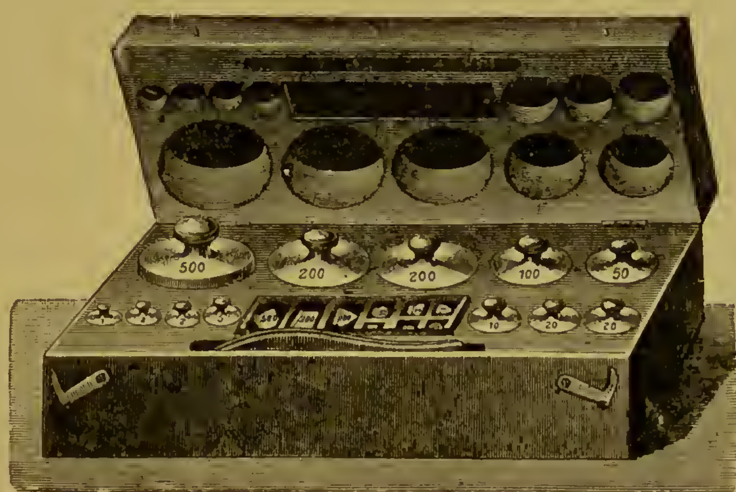


Fig. 2.—Gram Weights.

in this little piece of dough that the yield of bread from the flour can be calculated, the extremest accuracy is necessary; hence it is better to weigh the dough and, by deducting the weight of flour, get the actual weight of water used. As there is some difficulty in judging accurately whether the small dough is of the right stiffness, and as the calculation for yield depends on this being correct, it is better, if time will allow, to make two, or even three, of those small doughs, and the error in one estimation may then correct the error in another, and so the mean of the two or three will be about correct. The weight of the small piece of dough having been ascertained, the yield of bread from it is calculated in the following manner. Suppose the dough weighs 30·5 gm. Subtract from this the weight of flour used, 20 gm.; and the remainder, 10·5 gm., is the weight of water. As the ratio of water to flour is thus ascertained, it is no longer necessary to deal with grams, for the same ratio will obtain if the quantities are pounds, or hundredweights, or any other weight. Thus, if

Value of Average Estimation.

Calculating Yield from Water Content.

20 gm. of flour takes 10·5 gm. of water to make dough of a eertain stiffness, then 20 lb. of the same flour will require 10·5 lb. of water to make dough of a like eonsisteney. It is easy, therefore, to ealeulate how mueh water would be required to make a whole saek (280 lb.) of the same flour into a like dough. The amount is $\frac{280}{20} \times 10{\cdot}5 = 147$ lb. From this the total weight of dough produeed ean be ascertained, thus:—

Flour,	... ...	280 lb.
Water,	... ...	147 „
Yeast,	... ...	1 „
Salt,	... ...	3 „
Total,	...	431 „

But it is not possible to ferment this dough for some hours and then scale it into 2-lb. loaves without losing some weight. This loss varies, but a

Loss in Weight of Dough in Bulk. fair estimate is about 12 lb., thus leaving only 419 lb. for actual distribution. The weight of a 2-lb. loaf in dough is 2 lb. 3 oz., so if 419 lb. is divided into pieees for 2-lb. loaves (the loss in weighing has been already allowed for), there would be 191 sueh loaves and a few ounees over. This would be the equivalent of 95½ quarterns (4-lb. loaves). If dough were made mueh lighter, as for tin bread, the yield would of course be a little greater. When this method of ealeulating the yield of bread is employed regularly it is best to prepare a table of reference, so that, given the water absorption, the yield of bread ean be seen at a glanee. Thus, if ratio of water to flour were—

Flour.	Water.	Yield would be
20	10·5	191 2-lb. loaves
20	11	194·7 „
20	11·5	197·9 „

and so on, a difference of ·5 of a gm. in a dough with 20 gm. of flour making a differenee of fully three 2-lb. loaves in a saek of flour.

The small pieee of dough whieh forms the basis of the above ealeulation also serves for gluten estimation. After being weighed, it is returned

Determination of Wet Gluten. to the basin in whieh it was made and eovered with water, and allowed to lie in the water for half an hour. At the end of that period the washing may begin. The most convenient manner of doing this is to use a clean basin of about 1 quart eapaeity. This is filled to about 1 in. from the brim, and the hand, with the small pieee of dough in the palm, is immersed in the water, and the dough teased out and manipulated with the other hand. The water will soon become milky-white, and the gluten at first is rather soft. The water in the basin is earefully deeanted, being allowed to pass over the edge of the basin in a very thin stream. This preeaution is to prevent the loss of tiny partieles of gluten whieh may have passed through the fingers while washing was proceeding. These little pieees will all be found in the basin after the

water has been poured off. This proeess of washing and deeanting is repeated about four times, using elean eold water on each oecasion. When the water in whieh the gluten is washed remains quite clear after the washing, then the gluten may be considered elean and free from starch. It is then weighed in the wet state, but to get anything likc reliable results great care is needed. If more water is left in the wet gluten than is required to hydrate it, then obviously to this extent it is water that is being weighed and not gluten. The preliminary operation to weighing is therefore to press out as mueh of the water as possible. When it is ready for weighing, it will be found that the gluten stieks very tenaciously to the fingers, or, in faet, to anything of an absorbent nature that it touehes. As long as it is over-wet it will not stiek, but is easily handled. To press the surplus water out, it is necessary to rub vigorously between the palms of the hands, drying the hands on a towel between the rubbing and pressing operations, for it is important to get the excess water from the eentre as well as the outside of the gluten. When it beeomes stieky all over, it should be smartly transferred to the pan of the balanee and weighed. As this is the amount of wet gluten obtained from 20 gm. of flour, then the amount in 100, or the pereentage, will be found by multiplying by 5, since 100 is 5 times 20. On aceount of the diffieulty of expressing the water to always exaetly the same degree, it is better to wash the gluten from two or three small doughs from eaeh kind of flour, and take the mean of the three weighings; the result thus obtained is likely to be fairly aeeurate. The weight of wet gluten is usually stated in percentages. There is a definite relation between the quantity of wet gluten and the quantity of dry; the latter is roughly estimated as being one-third of the former, or, in other words, it is assumed that dry gluten takes twice its own weight of water to hydrate it. The dry gluten is therefore found from the weight of the wet by dividing the latter by 3. Some use the faetor 2·75 as the divisor, but in either ease the result can only be a rough estimate, owing to the uneertainty as to whether or not all the excess water has been pressed out. On this aeeount dry gluten should only be aseertained in this way when time will not permit of its being dried properly.

Mode of Preparing Wet Gluten for Weighing.

Relation of Wet to Dry Gluten.

To dry gluten it should be placed on a small pieee of tin whose surface has been rubbed over with oil, which is afterwards eleaned off. The tin is accurately weighed, and placed in a small drying oven (fig. 3), the temperature of whieh is kept eonstantly at 212° F. The gluten will first soften and run out more or less flat; then it will toughen and ultimately harden. When it has beeome quite hard, it may be weighed and again placed in the oven. It may be reweighed at intervals of one hour, and when it eeases to lose weight—when two sueeessive weighings are alike—its weight may be taken as that of dry gluten. Drying in this manner at a low temperature takes a very long time, as mueh probably as 36 hours. Fairly aeeurate comparative results may, however, be obtained by drying in an ordinary baker's oven at a much higher temperature, say

Determination of Dry Gluten.

360° to 380° F. The method is the same as in the other case, and the test for the completion of the drying process is also the same. In this case the gluten will not soften and run out, but will spring up into a light round ball. It must not be assumed, however, that the size and lightness of this ball of gluten are the measure

Drying Gluten at High Temperatures.

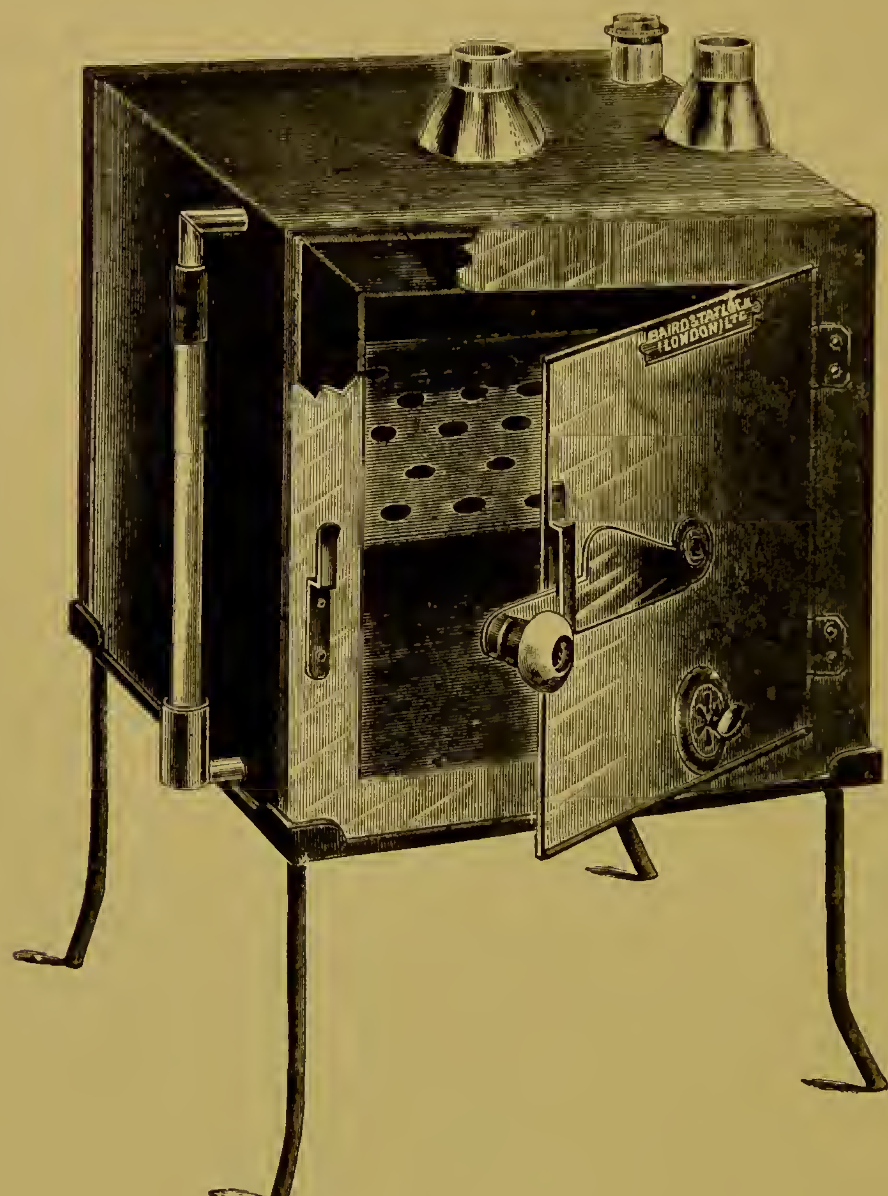


Fig. 3.—Drying Oven

of its strength or quality, for two pieces of the same gluten may have quite a different appearance when dried in this way. If one is placed in the oven immediately it is washed, while the other is allowed to lie some time, the latter will spring more, and become lighter than the former; but even this rule does not always hold. The glutens of very tough flours do not become very large unless allowed to lie some time after washing, whilst those of milder and softer flours spring better. When the gluten is thoroughly

dried, its weight is taken as that of true dry crude gluten, and, as before, if multiplied by 5 (assuming 20 gm. of flour to have been used), the answer is the percentage of dry gluten. As the drying process is purely mechanical and does not depend on the personal factor, it is much more reliable as an estimate of gluten in flour than the wet-gluten determination. While drying in a baker's oven in variable temperature is not, from a scientific point of view, so reliable as drying in the steady low temperature of a water oven, yet comparative results as between one flour and another can be thus obtained on which dependence can be placed. As a general rule, flours containing from 10·5 to 11·0 per cent of dry gluten are most suitable for bread-making, not because the quantity is so material, but because wheats which produce flours containing this quantity are also those which contain gluten of the requisite strength, and are yet mild enough for this purpose.

General Averages of Dry Gluten in Flour.

To ascertain the quality of gluten in respect of stability and elasticity, various methods have been proposed which deal with the gluten itself after it has been washed from the flour, but much more reliable results are obtained by using the flour itself for the test, since the gluten is the only thing in it which gives the flour stability and elasticity. For this purpose the flour to be tested is made into a thin ferment, with a small quantity of yeast and water, and fermented in a graduated glass cylinder (fig. 4) at a steady temperature. When the gluten of the flour is stretched by the evolved gas to its utmost extent, it breaks, and the ferment drops. The distance through which it has risen in the cylinder, from the point at which it started to that at which it drops, is taken as the indicator representing the elasticity of the gluten. It is also to some extent, but not absolutely, a measure of the flour's stability, for while soft glutens are less resistant to the action of the yeast, &c., yet the strong flours are not long enough in contact to be seriously affected, but will break and drop before those that are much softer but more elastic. To ensure that the temperature is kept uniform, it is necessary to keep the cylinders in a water bath while fermenting. The test is only a comparative one, and to make accurate comparisons between flours it is necessary to adopt a standard width of cylinder for all tests, to use always the same quantities of materials, and to adopt a standard temperature at which to work all ferments. The writer has found that a cylinder of 1½ in. internal diameter, and about 550 c.c. capacity, answers the purpose of this test very well. The ferment consists of 1 oz. (28·35 gm.) flour and 1½ oz. (42·52 c.c.) water, and ¼ oz. or 7 gm. yeast. The yeast is dissolved in the water in a small basin, and the flour then added and stirred with a spatula, or the blade of a table-knife, until it is quite smooth. The degree of mixing is of much importance. The mixture must not contain lumps, or the elasticity of the ferment will be reduced,

Quality and Stability of Gluten.

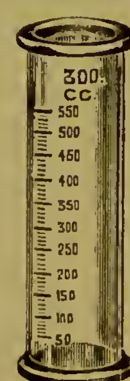


Fig. 4.—Graduated Cylinder

Standards for Comparative Purposes.

and it must not be stirred too much, or the elasticity will be considerably increased, for it is one of the peculiarities of gluten that it becomes more elastic the more it is stretched. When the small ferment is properly mixed, it is carefully transferred to the cylinder, and the point it stands at is noted. The cylinder is then placed in the water bath, which should be kept at a temperature about 90° F. It would be better if the temperature of the water used to make the different ferments were also 90° F., but, in practice, there is much difficulty in ensuring that each is at exactly the same temperature, owing to the small quantity used and the possible variations in loss. For this reason it is better to make the ferments with water at or near the temperature of the air for the time being. All the lots made at once are then certain to be at the same temperature, and stand equal chances in the water bath of rising in temperature at the same rate. But if it is proposed to keep a record of results, the ferments must all be made about the same temperature, say 75° F., as this is not very much removed from ordinary temperature in either summer or winter in a warm room. The time taken to rise in the cylinders depends mostly on the yeast; yet, when two or more lots are being fermented together, the time is a factor of some importance, indicating to some extent whether the flour is one that ferments quickly or slowly, for there is a good deal of difference between them in this respect. When the ferment is at its maximum height it breaks and drops, leaving its mark on the cylinder, so that it can be noted at any time. In a cylinder of the size given, with the quantities of materials stated, the flour with the highest elasticity will rise through about 260–280 c.c., whilst one with the lowest may not rise more than 150–160. This test is reliable only for certain types of flour. Hard flours are not elastic until acted upon for some time by yeast and its products; consequently hard flours drop sooner in the cylinders than their strength would lead us to anticipate. But for all flours with mild glutens up to about 11 per cent the test is a good indicator of their strength; and if strong flours are contrasted only with those of the same class and nature, it indicates their comparative value.

Causes of Variable Results.

Comparative and Record Tests.

General Range of Flour Elasticity.

Limits of Elasticity Test.

As a concluding and confirming part of the other tests on a sample of flour the actual baking test should be performed. When, as sometimes happens, it is not possible to obtain more than about 8 oz. of the flour to be examined, there is some difficulty in baking it in the ordinary way; yet this can be done quite successfully if the small piece of dough can be kept in an incubator, or even in an ordinary prover if the temperature is equable. By paying careful attention to this dough, all its peculiarities can be noticed as well in the small piece as in a large one. A much more convenient quantity of flour for a baking sample is 5 lb. With this should be used 1 oz. of yeast, 1 oz. salt, and 1 quart (2½ lb.) water, at a temperature of 100°–104° F., according to the season. A comparatively high

Baking Tests.

Materials and Conditions for Small Baking Test.

temperature is necessary for such a small dough, because of its cooling rapidly while making. The yeast is dissolved, or, at least, thoroughly mixed with the water, then the salt, and the dough is mixed straight off, care being taken not to make any scrap and to mix thoroughly. The mixture is placed in a clean enamelled basin, and covered with a dry cloth, with damp one on top of that, or, failing this, wrapped up in a clean sack, a cotton one for choice, and placed in a drawer or in a prover where the temperature is equable and is as nearly as possible about 80° F. The dough itself, when first made, should be at 82°-84° F., and during fermentation the temperature will increase in the first hour or so in the centre to about 86°-88° F. In any case, it must be kept well away from draughts and prevented from skinning. When it has lain for one hour it is kneaded, and the same operation repeated each half hour, till the dough has lain 2½-3 hours from the time it was made. If the previous tests for quantity and quality of gluten have indicated that the flour belongs to a soft variety, the shorter period mentioned, or even less, would be sufficient, whilst if the previous tests have shown the flour to be of a strong, hard nature, the longer period would be necessary to ripen the dough properly. When the dough is ready, it is scaled and handed up or moulded into loaves. Coburg shape (see Plate VI, No. 4) is best for crusty, if such a small lot is made, and one loaf may be moulded into a tin. The crusty loaf will require about 25-30 minutes to prove, and the tin with a dough so stiff as this about 45 minutes. They are then baked in the usual way.

Use of Gluten Determinations in Baking Tests.

The points to notice about the bread when baked are:—(1) Bulk and shape; (2) Colour and bloom of crust; (3) Colour and pile of crumb; (4) Texture and sheen of crumb; (5) Flavour and moistness. The bulk of a loaf made under the above conditions will depend almost wholly on the nature of the flour. If it is inclined to be stogy, the loaf will have a small bound appearance, probably with cracks in the side, but will otherwise be quite shapely—will, indeed, come from the oven nearly the same shape as it went in. If the flour inclines to be runny, the loaf will be flat on bottom and slightly flat on top. If the loaf is bulky, and has its corners rounded at bottom, and the cuts on top opened out wide, with the centre well bulged up, then the flour may be considered of high quality as far as strength is concerned.

Points of a Loaf: Bulk and Shape.

The colour and bloom of a loaf do not depend wholly on the nature of the flour, but to some extent on the yeast, and principally on the extent to which the flour has been changed during fermentation. Should the loaf have a yellowish-brown colour, with a fine crust, and look bright, then it may be inferred that the time allowed has been just right, and that the flour was strong enough to stand fermenting to that extent, the brightness and fineness also indicating that it is of high grade. On the other hand, should it be dull and reddish and rough, the colour would indicate that it had not been fermented enough, and the roughness that it belongs to a low-grade class. If the loaf is pale and dull and bound-like in

Colour and Bloom of Crust.

appearance, this shows that it has been fermented too much, and that the flour is not strong enough to bear so much.

Colour and pile of crumb depend partly on the colour of flour used, and partly on the extent to which it is fermented. It is quite possible to make a loaf with the crumb greenish-yellow from a flour that is quite white, but this appearance is the result of the dough having been much under-ripe; on the other hand, from a white flour the crumb of loaf may be a dull, bleached-looking white, the result of the dough being over-ripe. Accordingly, if a loaf has a bright colour, such as would be expected from the colour of the flour used, it has been fermented to the right degree. This test must, however, be considered in conjunction with the others. It is the gluten of the flour which thus changes colour during fermentation: it is really bleached. The "pile", by which is meant the smoothness and silkiness of the crumb when cut, is the result of the manner in which dough is manipulated, but a nice pile cannot be produced with dough that is either under- or over-ripe, for in the one case it is tough, in the other crumbly.

Colour and Pile of Crumb.

Texture is by some confused with pile. What is called texture really refers to the condition of vesicularity. If the tiny holes, or vesicles, in the crumb of a loaf are small, all one size, and evenly distributed, we call the texture *fine*; if they vary in size, or if they are small in one part and large in another, or if amongst the small ones there are several very large, then the texture is called *bad* or *coarse*. Texture is made in the dough stage by plenty of kneading. In a piece of dough moulded up and baked without any kneading whatever, the crumb of loaf will be open in texture, not unlike a honeycomb, but the more frequently it is kneaded the smaller the vesicles become. It is much easier to make a fine texture with strong, stable flour than with soft and weak, and easier with high grade than with low. Sheen in the crumb of loaf can only be produced with high-grade flours; bread from low-grade flours, however even the texture may be, has always a dull appearance. The transparency of the crumb of a loaf made from patent-grade flour has something to do with the appearance of this sheen, which is a sort of sparkle reflected from the sides and bottoms of the tiny holes in the crumb. It only shows in bread that is fermented just enough, and not in that either over- or under-ripe.

Texture and its Cause.

Sheen or Sparkle in Crumb.

It is a mistake to think that the moistness of a loaf depends wholly on the quantity of water it contains. One that seems quite dry in eating may contain as much water, or even more, than one that eats moist. The difference in the sensation on the palate is due to the condition of the gluten in the bread. If this has been sufficiently ripened in dough, the bread will seem soft and moist; if it is either under- or over-ripe, it will seem dry, but the sensation of dryness arises from a different cause in the two cases. In the first case the bread is dry because of the toughness of the crumb and the difficulty with which it mixes with the saliva to form a bolus in the mouth. The absence of flavour is due to the insolubility of

Moisture in Bread.

those parts which possess flavour, and the sensation imparted to the palate is much like that produced by fine shavings or bran. When the dough has been over-ripe, the sensation of dryness is still caused by the difficulty in getting the bread in the mouth to mix with saliva and form a continuous paste; it is crumbly, and will not stick together. The flavour of bread is in some degree dependent on its moistness, and some people have in fact a difficulty in distinguishing between the physical sensation due to the latter and flavour proper, which can only be produced by the soluble substances in bread. It is not certain what constituent of bread really produces flavour, but it evidently depends in some degree on the change that has occurred in the gluten during fermentation, though also on the modifying effects of the alcohol and acids produced at the same time. Bread flavour is, in fact, a blend of many flavours. It reaches its maximum sweetness when a certain amount of acid has been formed; but the continued production of acid, as fermentation is allowed to proceed, gradually masks, and ultimately quite hides, the flavour due to the flour alone, and then sourness predominates. It is usual to try the flavour of bread by smell, but this is an effective test only when the bread is quite new and at the moment of cutting. In conjunction with smelling it should always be a rule to chew a small piece of the crumb of the loaf for some time, and note the flavour while chewing as well as after the bread is swallowed.

Cause of Flavour.

Gradations of Flavour to Sourness.

Testing for Flavour.

The above tests for flour, singly and in conjunction, should produce sufficient and reliable data for estimating all the properties that concern the baker. For the purpose of comparing flours on a uniform system and standard it is necessary to adopt a definite form in which to state the points, thus:—

Summary and Record of Flour Tests.

Name or Brand.	Grade.	Colour.	Yield.	Wet Gluten.	Dry Gluten.	Elasticity.	Remarks.

Colour would be given in figures, using as the standard some well-known flour of which a supply could always be had. Both wet and dry gluten would be given in percentages, elasticity in figures obtained as already described. The column for remarks would contain notes as to any peculiarity in behaviour of the flour in dough, and the kind of bread produced from it. A record of this kind is extremely useful for reference.

CHAPTER XII

COMPRESSED YEAST FOR THE USE OF BAKERS

It is not proposed here to enter into a thorough scientific examination of yeast, but it is essential that some of its peculiarities should be explained if its working in dough is to be understood. In a subsequent part of the work chapters will be devoted to the various sorts of home-made barms still much in use in Scotland, Ireland, and in several of our colonies, and the methods of using them; but the general description of yeast as a plant, and its properties, which are common to all kinds of barms, will be best given as preliminary to the description of the almost universally used compressed distillers' yeast.

Nature of Yeast.

Yeast in a biological sense occupies a position midway between the animal and the vegetable kingdom. It consists of minute cells, with walls composed of fine *cellulose*, and interior contents consisting principally of living matter called *protoplasm*. It is on account of its cell wall being composed of cellulose, and because of a property it possesses of producing protoplasm from an organic salt of ammonia, that yeast has been classified in the vegetable kingdom—as a plant.

Why classed as a Plant.

Fig. 5.—Yeast Spores

From E. L. Trouessart's *Microbes, Ferments, and Moulds*, by permission of Messrs. Kegan Paul, Trench, Trübner, & Co.

Essentials in Yeast Food.

It must always contain water, and, as its substance is essentially albuminous, the material on which it lives must contain albumin, or some substance from which the yeast can produce this, if it is to reproduce new yeast cells. Sugar or some substance capable of being changed to sugar must also form part of its food, the theory being that the yeast breaks up sugar in order to obtain a supply of oxygen, which seems essential to its life, and that when the equilibrium of the sugar molecule is destroyed, it is re-formed in the interior of the yeast cell into two compounds, alcohol and carbon dioxide, with minute quantities of succinic acid, glycerin, &c. Without proceeding to details at present it may be said that yeast uses sugar for a function somewhat similar to respiration, and it uses albumin or proteids for reproductive material. Yeast can reproduce itself (see Plate, YEAST, &c.) in two distinct ways, by *budding* and by *sporulation*.

Yeast Budding.

When it is in a medium containing sufficient food of the proper kind, it reproduces itself by budding. The cell enlarges at one end, forming a protuberance, and this contracts at the part nearest the parent, forming a neck which ultimately closes, and the bud then starts a separate existence, producing buds of its own, although still adhering to the older cell. In this way a branched formation of cells may be produced, but the more common form is in pairs or clusters of three or four cells.

Spore Formation.

The conditions under which spores (fig. 5) are formed are entirely different.

Functions of Spores.

Spores are formed inside the yeast cell, and consist of the living matter concentrated into small particles, which are capable of living by themselves. It is supposed that a part of the protoplasm called a nucleus is the seed or essential part of a yeast spore. The contents of a yeast cell may be formed into two, three, or four spores. These appear first as spots of greater density than the rest of the cell; then they assume a round shape, and ultimately acquire a covering or skin of their own. The skin of the cell containing them then breaks, and the spores are set free. In the spore stage they do not perform the functions of ferments. They are inert, but capable of retaining their vitality for a long time, probably for years, and when placed in a suitable medium they are again changed in form and become actual buds, reproducing more buds and fermenting in the ordinary way. Spores not only live longer, but withstand greater degrees of heat or cold than yeast cells without damage.

Conditions of Spore Formation.

Spontaneous Fermentation.

Spores are formed only from young and vigorous cells kept in a moist condition and quite deprived of all nourishment. They are not easily produced artificially, but the most approved method is to wash some fresh yeast over the surface of a piece of plaster of Paris which is surrounded with clean distilled water. If old cells are placed under such conditions, they simply decay. Whilst yeast cells in suitable conditions grow very quickly, spores are only formed very slowly, the time, according to Schützenberger, being from two to fourteen days. As spores re-form cells only very slowly, it will be seen that spores take no part in bread fermentation. In the case, however, of barms which are allowed to start fermenting spontaneously, it is more than probable that they are first inoculated with yeast spores rather than with buds, for the presence of the former in the air is undoubted.

Conditions of Yeast Budding.

Why Sugar is not a sufficient Food.

Conditions of Maximum Yeast Growth.

The budding of yeast depends on the nature of the solution in which it is placed. In a solution containing sugar only, while it produces a large quantity of gas, it cannot produce an equivalent quantity of new yeast cells, because there is no nitrogen in sugar, and as albumin, which is the basis of protoplasm, contains a proportion of nitrogen, therefore in a sugar solution the only buds a yeast cell can produce must be supplied with their protoplasm from the material of the parent cell, causing the exhaustion and ultimate death of the latter. The condition under which it has been found that yeast grows to the greatest extent is when there is only a moderate quantity of sugar present, when the solution contains the necessary mineral matter, and albuminoids in the form of peptones, which is the only form that yeast can easily assimilate, and when the liquid is impregnated with free oxygen (ordinary air).

Commercial Yeast.

We speak loosely about bakers' yeast being distillers', but the manufacturers of yeast are only distillers incidentally. It is impossible to prepare yeast without at the same time producing spirit, and to prevent loss this spirit must be distilled from the liquid after the yeast is removed. In a distillery, where the manufacture of spirit

is the prime consideration, there is no desire to make more fresh yeast than is necessary for the production of spirit, at the same time that the maximum quantity of spirit is wanted. To secure this end the solutions consist very largely of sugars or other material that is readily changed to sugar, such as boiled starch, with albuminoid matter sufficient only to keep the yeast strong and vigorous, and in this case the absence of air in the liquid

Conditions of Manufacture.

is an advantage. But when yeast is the prime product of the factory, and spirit merely a by-product, then the wort or solution in which it is grown is made much richer in peptones, and has air pumped into it while the fermentation is proceeding. By this alteration the quantity of new yeast is increased to five or six times the amount that would be produced in an ordinary spirit distillery. This improvement of the process has made pressed yeast much cheaper than it was some twenty years ago, and the extraordinary care exercised in its manufacture has resulted in a product of great purity and uniform quality.

At one time, as a means of cheapening yeast, a quantity of starch was mixed with it before pressing. This, in some cases, was honestly sold as

Pure and Mixed Yeast.

mixed, at a lower price than pure. The admixture of starch was credited with improving the keeping qualities of the yeast. It has even been suggested that the addition of starch may actually increase the quantity of yeast cells in a given weight of the mixture, since the dry starch replaces not the yeast but some of the water surrounding it. The experiments on which this opinion is based fail to convince, because there is no proof that the pure and the mixed yeasts dried

Effects of Starch mixed with Yeast.

in each case were the same yeasts, and that they had been pressed to just the same extent. The addition of starch makes it possible to press yeast somewhat drier, but this is really a doubtful benefit. In any case the practice of using starch is now almost given up in this country and in Continental factories that supply our market, but is still common in America. It has been found that it is easy to press yeast by itself quite dry enough, and that the pure article keeps really better than the mixed. The peculiarity of the pressed yeast now used by bakers is that it is quick-working and has plenty of vitality. These properties have been intensified by selection and by the kind of medium used and the conditions employed for the yeast growth.

Many attempts have been made to prepare yeast in a perfectly dry state, so that it might be kept for an indefinite period, but the success

Dried Yeast.

attending these efforts has been very small. The best results hitherto obtained in this direction have been with *yeast cakes.* These consist of a large proportion of yeast mixed with fine corn or barley meal, cut into round biscuits about ¼ in. thick, and then very carefully sun-dried. Similar sorts of cakes were known and in use in this country quite a hundred years ago.[1] They are still manufactured in America, and are in use in places where it is impossible to obtain a supply of fresh yeast. These

[1] Yeast cakes were in use by bakers in Rome at the beginning of the first century. See Chap. I, page 3.

yeast cakes start fermenting very slowly, and probably their vitality has been retained by spores rather than dried buds. They require to be used in a sponge which must stand several hours, generally overnight, before dough is made. They are really only suitable for domestic use.

Pressed yeast is usually packed in canvas bags, unless bakers are supplied near the factory, in which case it is made up in oblong blocks wrapped in paper. If kept in a cool place in the original canvas bag, the yeast is in good condition to use for about ten or twelve days in winter and five or six days in summer. The common plan to keep it fresh is to dip the bag with the yeast in clean cold water, once or even twice a day, and then place it between two boards with weights on the top one, or in a small press not unlike a letter-press. Another expedient to assist keeping which is more efficacious than that just mentioned, and which is particularly suitable for small lots, is to remove the yeast from its original covering and press it firmly in an earthenware jar. The jar is then kept in another vessel of water and covered with a damp cloth, the ends of which are allowed to touch the water. If this is kept in a moderately cool place, the yeast, even in summer, keeps quite sound for a week or eight days. Yeast must not be allowed to freeze, but it can be reduced to nearly the freezing-point without hurt. The writer on one occasion kept some yeast at a temperature of 40° F. for twenty-eight days, and it was quite fit for use at the end of that time, but was showing signs of softening.

Keeping Properties of Fresh Yeast.

Expedients for Keeping Yeast.

When a piece of yeast is kept in a warm, dry situation, it becomes white and crumbly, and in the centre of the mass it is quite hot. This heat is the effect of chemical action going on in the yeast. This is really a sort of incipient fermentation by which the yeast changes the composition of its own substance. Whenever this starts, the yeast loses strength as a ferment very quickly, and if used for bread-making the quantity must be much increased. When it has acquired an old or a cheesy smell, it is better not to use the yeast at all. If yeast is kept in a warm, moist place, instead of becoming white, dry, and hot, it becomes brown and soft, ultimately acquiring a bad smell, and, of course, it is not then fit to use. According to Schützenberger, softening of yeast is not directly due to putrefaction: "It grows soft and converts its protoplasm and a part of its contents into soluble principles, among which M. Béchamp distinguished leucine and tyrosine, a soluble albuminous substance coagulable by heat, a ferment producing change, a gummy substance, phosphates, and acetic acid; these are accompanied by the production of alcohol and carbon dioxide as well as by the disengagement of pure nitrogen". Whenever yeast shows the appearance of softening, it is useless as a fermenting agent for bread and should not be used.

Signs of Decay in Yeast.

Changes in Softened Yeast.

CHAPTER XIII

EASY METHODS OF TESTING YEAST

Colour and General Appearance.

As occasions are always arising when it is necessary to judge of the character of a yeast before using it in quantity, it will be well to describe here one or two simple marks and signs by which superior may be distinguished from inferior quality. The colour of yeast is not now a good indicator of its character, but may only show the nature of the material in which it has been grown. Thus, when much rye has been used in the wort, the yeast is yellowish in colour, whilst if maize has been the principal ingredient, the yeast is paler. That in which starch has been mixed before pressing is greyish and more friable than the pure. If brewers' yeast has been mixed with distillers', the mixture is more or less brown and tastes slightly bitter. Good yeast should feel tough and springy, and when broken should show a clean fracture and should break with a snapping sound. It should smell somewhat acid, like apples, and should be practically tasteless.

Rough Test with Sugar Solution.

The fermenting strength of yeast may be roughly tested by the following method. Into half a pint of water dissolve half an ounce of sugar. Any sort of sugar will serve, so long as all the tests between which comparisons are made are done with the same kind and quantity. This solution, or a part of it, is poured into an ordinary glass tumbler, its temperature being 90° F. Half an ounce of the yeast to be tested is then weighed and moulded into a round ball: this is dropped into the solution, and will at once fall to the bottom. In a few minutes it will rise to the surface. The fermentative strength of the yeast is indicated by the time it takes to rise in the solution; the strongest comes up quickest, and the weakest will come up last. As the success of the test depends on the density of the solution, it is necessary that the water should be measured and the sugar weighed accurately, and the temperature properly regulated. When one test has been carefully made with a yeast of known strength and the time it takes to rise noted, then this may be adopted as the standard, and in all subsequent tests the yeasts compared with this and classified as quicker or slower according to the time they take to rise to the surface.

Why Yeast rises in Solution.

The explanation of the rising of the yeast in this way is very simple. The solution contains sugar, and the yeast, on the outside of the ball into which it has been formed, breaks up the sugar into alcohol and carbon dioxide. The latter gas adheres in little bubbles to the ball of yeast, and when there is a sufficient number of them, they act like so many little bladders, which carry the yeast ball to the surface. Yeast, therefore, which acts on the sugar quickest, is that which will first produce the requisite number of gas bubbles to lift it to the surface. The value of the test is dependent also on the dryness of the yeast. A true

comparison can only be made between yeasts containing about the same quantity of moisture. A yeast may be too dry to stick together in a ball at all, or, if it does, too light to sink in the solution. In a case like this it is necessary first to mix the yeast with a small quantity of water, until it has acquired consistency sufficient to allow it to adhere, then to weigh the quantity from this mixed piece, and proceed in the way described above. The test is an old one, and gives only rough results.

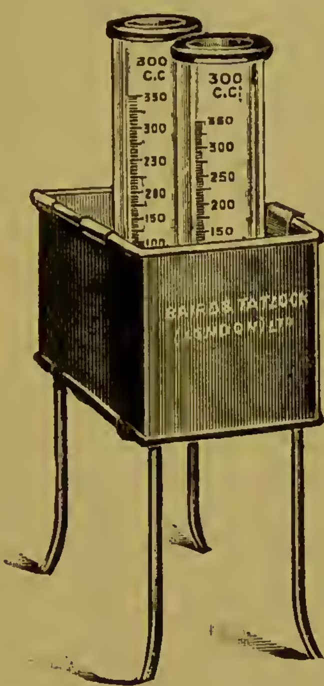


Fig. 6.—Cylinders in Water Bath

Ferment Test for Yeast.

A more reliable way of testing the speed at which a yeast works is by the use of a small ferment in the graduated cylinders already described for testing elasticity of flour (fig. 6); but in this case the indicator of strength is not the dropping point of the ferment, but the distance through which it will rise in a given time—twenty minutes is a convenient period. The ferment may consist of the same quantities of materials as already given for flour-testing, viz.: 1 oz. flour, 1½ oz. water, and ¼ oz. yeast. This is made up smoothly in a small basin and transferred to the cylinder. The flour paste retains the gas produced, and rises in exact proportion to the quantity of that gas. The reading has to be taken before the ferment drops, and as there is not much danger of its dropping or even of much gas escaping within twenty minutes, that time is convenient to fix for a standard. In this test it is important that the materials should be accurately weighed, and the temperature nicely regulated so as to be the same for each sample. The temperature of all ferments between which comparison is to be made should be alike, whether the tests are made several at a time or singly at different times. As a standard temperature 90° F. may be selected. To obtain this temperature the water used for making the ferment itself should be about 96° F. The ferments are placed in a water bath and maintained at a temperature of 90° F. while they are under observation. This test, if carefully performed, is very reliable, and does not require the use of any expensive apparatus.

Temperature for Test Ferments.


Fig. 7.—Yeast Bottle

Weight of Gas Production from Sugar Solution.

For results to be tabulated for reference, the best test as to yeast strength is obtained by fermenting a given weight of yeast in a simple sugar solution of known density, and weighing or measuring the quantity of gas produced. There is a small piece of apparatus called a *yeast bottle* (fig. 7) adapted for this purpose, if the weight of the gas is to be ascertained. About 50 c.c. of water are taken and 5 gm. of sugar thoroughly dissolved in it; in this 1 gm. of yeast is diffused, and the whole liquid

then transferred to the yeast bottle, which is fitted with a rubber cork. The bottle and its contents are then accurately weighed on the balance. It may be reweighed every hour, the loss in weight each time being the weight of gas which has escaped, for there is an open tube through which the gas escapes as it is formed. The bottles—it is usual to make two tests at once—should be kept at a constant temperature of say 90° F. while fermentation is proceeding. To give good results this test must be performed with great accuracy, owing to the small quantity of yeast used and the very slight differences between the weighings. The results are

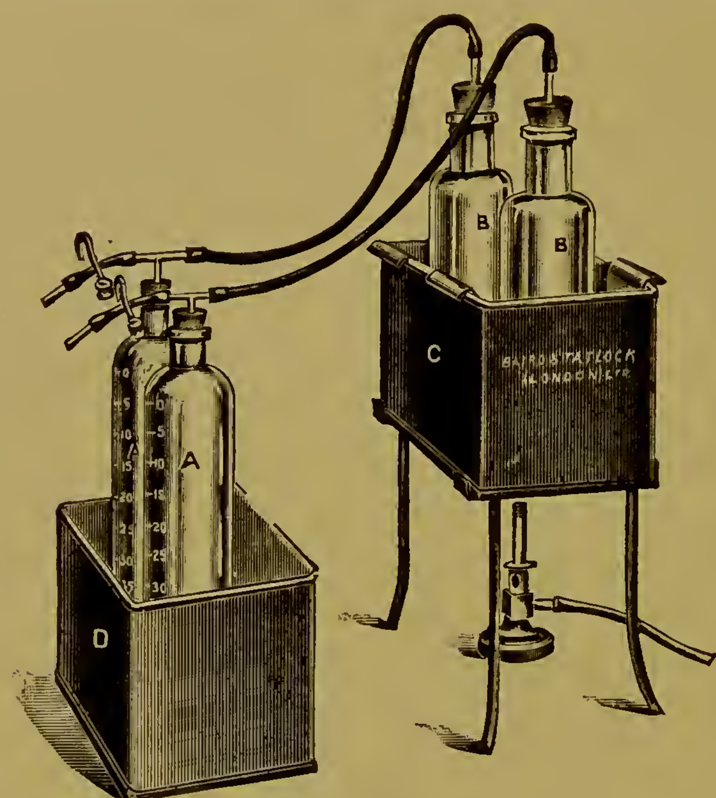


Fig. 8.—Yeast-testing Apparatus

obtained in fractions of a gram, and one result can easily be compared with another, while it is easy to calculate the volume of gas corresponding to any given weight, if comparison is wanted between a result thus obtained and one in which the gas has been directly measured by volume.

Test by Gas Collection.

The latter method is simpler and on the whole more accurate. The necessary apparatus (fig. 8) is not elaborate or costly, and requires no special skill for its manipulation. It consists of two baths, C and D, one on an iron stand tall enough to allow a Bunsen burner to be placed underneath. This bath has a false bottom extending to within half an inch of each end, and two hanging shelves on which to place the bottles with the fermenting liquid. The purpose of the false bottom is to prevent the hot water from rising directly above the Bunsen burner, and impinging at once on the bottoms of the fermenting bottles. The false bottom forces this heated water to make its way to the ends of the bath

before it reaches the bulk of the water at all. Convection currents are thus set up, which make the heat of the water uniform. The fermenting bottles, E, B, are placed on shelves which are immersed in the water, so that their contents are kept practically at the same temperature when there are two or more bottles. The fermenting bottles are ordinary wide-mouthed ones fitted with rubber corks with one hole in each, through which a piece of glass tubing is passed. This tube is connected by rubber tubing to one end of a glass T-piece. The other arm of the T-piece has another short length of rubber tubing, closed with a plug of glass rod. The stalk of the T-piece is passed through a rubber cork in the gas-collecting cylinder, A. This is a long jar with no bottom, graduated in cubic centimetres or cubic inches. As the jars are about 2½ in. in diameter, the latter graduation is more serviceable.

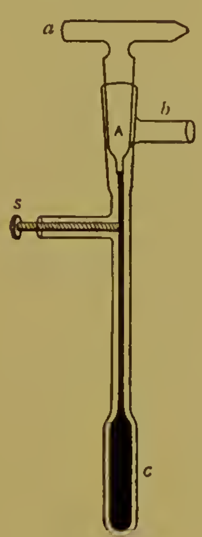


Fig. 9.—Gas-regulator

Mode of Setting Apparatus.

When the apparatus is arranged, the sugar solution with yeast is placed in the fermenting bottles and the corks all made secure. The apparatus is then exhausted by withdrawing the glass plug from the rubber tube, and sucking the air out of the cylinders one at a time. The latter stand in the second bath, which is filled with water or brine, and as they are exhausted of air and the atmospheric pressure removed, the water rises in the cylinders. It can be stopped at any desired point by replacing the glass plug. When it is to be set the water is pulled up till it stands at the mark 0 on the cylinder. The Bunsen burner is lighted if necessary, and the temperature of the water in the bath regulated with the aid of a thermometer, so that it keeps at about 90° F. If fermentation is to proceed for a long time, and it is inconvenient to watch it constantly, there is a piece of apparatus called a *gas-regulator* (fig. 9), which will automatically keep the temperature uniform. This instrument, which is filled with mercury, is partly immersed in the water in the bath. The gas supply has to pass through this apparatus before it gets to the Bunsen burner which heats the water. By means of a small screw the level of the mercury in the regulator can be so arranged that a rise of one or two degrees in the heat of the water above the temperature desired will expand the mercury so as partially to close the aperture through which the gas passes, and so reduce the size of the Bunsen flame, and bring the temperature of the water back again. As soon as fermentation starts, and the gas given off has a pressure equal to that of the atmosphere, it passes over into the collecting cylinders, and the water recedes as the gas enters. The amount of gas produced is therefore measured by the marks on the side of the cylinder. As pure water readily absorbs carbon dioxide gas, which is evolved by yeast, this in some measure falsifies the record, but as the rate of absorption is practically constant, it does not affect the comparison as

Use of Gas-regulator.

Absorption of Gas by Water.

between one time and another. But the slight error due to this cause can be removed by using in the bath containing the collecting cylinder a salt brine instead of pure water, as the former does not to any extent absorb carbon dioxide.

Why Sugar Solution is used for Test.

It has been already pointed out that sugar, while essential to the growth of yeast, is not a complete yeast food, and it may seem improper to use sugar only as an indicator of the fermentative strength of yeast. Its suitability consists in its comparative simplicity and stability, and in the fact that the yeast which is most active in breaking up sugar is also, other things being equal, the one possessing the greatest vigour as a ferment; but fermentation of sugar and yeast development in other ways are not interdependent functions. When tests are to be made with sugar only, it is important that all those compared should be done with one kind of sugar. The density of the solution should be ascertained, and care should be exercised in weighing the sugar and yeast and measuring the water. As the bottles in which fermentation takes place are much larger than the yeast bottles intended for weighing mentioned above, a larger quantity of solution can be used and a larger sample of yeast tested at once, and in this way the error of experiment is minimized. A convenient quantity to use in each bottle is 300 c.c. of water, in which is dissolved 10 gm. of sugar. In this quantity 7 gm. of yeast is diffused, and then the apparatus is fixed up as described. Readings are, with these quantities of materials, best taken every half-hour, and, for accuracy, it is better to readjust the apparatus so that the water starts each time from 0.

Precautions in Tests.

Standard Quantities for Tests.

Tests for Yeast Foods or Stimulants and Yeast Deterrents.

The same apparatus can be used to show the effects of yeast on flour, or the effects which any kind of yeast food or deterrent might have. It is usual to do two tests at once either as duplicates or for comparison, but as the bath will hold four bottles, that number of tests can be done at once with the certainty that the conditions in each bottle are the same. If care is taken in weighing materials and in keeping the temperature of the water bath uniform, the results obtained by this apparatus are very reliable. It may be obtained complete, except the gas-regulator, for about 21s.

CHAPTER XIV

SOLUBLE FERMENTS OR ENZYMES

Yeast excretes Enzymes.

Yeast is an organized body, that is, it has a definite structure, and if this structure is destroyed it ceases to perform the function of a ferment. But in addition to its action as a ferment, yeast excretes certain soluble substances which possess the property of changing certain organic substances into new compounds. Not only does

yeast contain such agents, but they are also contained in many vegetable and animal organs, their purpose being generally to prepare nourishment for the different organs or tissues in a form in which it can be assimilated. Thus in growing grain there is a substance of this kind capable of changing starch into a form of sugar suitable for the nourishment of the plant. Yeast contains one which changes cane sugar into a form of glucose, and another which changes proteids into peptones. In animals there are some in the saliva, in the juices of the stomach, in the liver, and elsewhere, effecting changes in the substance of the food to render it suitable for the body. In older works these agents were called *zymases* or *soluble ferments*; the more modern name is *enzymes*. They have no organized structure. On the general properties of soluble ferments Schützenberger says[1]: "They are all derived directly from living organisms, in the midst of which they originate. . . . The specific characters have not been communicated to any artificial organic substance. We are, therefore, compelled to believe that this specific character is a consequence of the origin of soluble ferments. Their composition resembles that of albuminoid substances; in fact, they contain carbon, nitrogen, hydrogen, and oxygen. But the analogy will go no further. When we have eliminated by proper processes the albuminoid substances which always accompany 'soluble ferments' in their first solutions, we find that the product, though it preserves all its chemical activity, no longer shows the general reactions of albuminoid substances. . . . The activity of 'soluble ferments' depends on the temperature, like that of organic ferments. In general terms we may say that it increases with the temperature up to a certain limit, beyond which it undergoes a rapid depression till it ceases altogether. This limit varies with the nature of the ferment; it is always under 100° C. (212° F.), and is found to be higher than that of organic ferments. The action of chemical agents on 'soluble ferments' is also not quite to be compared with that exerted on organic ferments. Thus M. P. Bert has observed that compressed oxygen destroys the latter ferment (yeast) after a longer or shorter interval, while 'soluble ferments' are not modified in their activity. M. Bouchardat has observed that certain substances which are antagonistic to alcoholic fermentation have no influence on the effects of diastase, such as prussic acid, the mercurial salts, alcohol, ether, chloroform, and certain essences (cloves, turpentine, lemon, mustard, &c.). Citric and tartaric acids, which only slightly interfere with alcoholic fermentation, completely destroy the activity of diastase. Dumas found that a solution of borax coagulates beer yeast; the supernatant liquid has lost the property of altering cane sugar; it also neutralizes the action of the water of yeast on saccharose. If sweetened water and the water of yeast are placed in one tube, and sweetened water with the water of yeast and a solution of borax

General Properties and Purpose of Enzymes.

Composition and Functions of Enzymes.

Effects of Temperature on Enzymes.

Action of Chemical Agents on Enzymes.

Effects of Essences and Ethers on Enzymes and on Yeast.

[1] Schützenberger on *Fermentation*, pp. 273-277.

in the other, the first will soon show signs of alteration, while the second will show none. Analogous effects are observed with synaptase, or emulsin, diastase, and myrosin. All these soluble ferments cease to act from the moment they are placed in contact with a solution of borax. This salt appears, then, to have a specific action in destroying the activity of all soluble ferments. We have seen, on the contrary, that yeast, placed in contact for three days with a saturated solution of borax, is able still to set up alcoholic fermentation. Borax may, therefore, like compressed oxygen, serve as a differentiating character of soluble and organic ferments. . . . Soluble ferments are able to act on various classes of compounds, but the mode of action is generally the same. There is a more or less simple splitting up, accompanied by a hydration. The nature of this splitting up is always conformed to the peculiar constitution of the compound, and may be explained, in most cases, by chemical processes in which the direct or indirect intervention of a living organism cannot be brought in. Thus starch is resolved by hydration into maltose and dextrin, and this in its turn is converted into glucose as well under the influence of diastase as by being boiled with a dilute acid (sulphuric acid). The 'alterative' ferment hydrates a molecule of saccharose and converts it into two molecules of glucose; dilute acids behave in the same manner."

Action of Borax.

Method of Enzymic Action.

There is a large number of enzymes which have been carefully studied within recent years, but our concern is only with a few included in the class called *diastases*, which have the property of changing starch into glucose, and to which class the enzyme called *invertase* of yeast also properly belongs. The other class is called *proteolytic*, and possesses the property of changing albuminoids or proteids into peptones or similar products.

Diastases.

Diastase is the enzyme peculiar to malt, and its characteristic action is to change gelatinized starch into maltose and dextrin, and if the maltose is removed as it is formed, the whole of the starch can ultimately be changed into sugar. The name diastase has been applied to all bodies capable of effecting this change in starch, whatever their source. The study of malt diastase virtually includes the study of all of them, although their action differs considerably in intensity.

Diastase of Malt.

Malt diastase is secreted when the barley starts to grow. It is not itself capable of breaking or dissolving the skins of the starch cells, but while the grain is growing there is supposed to be another enzyme, called *cytase*, which is capable of doing this; the diastase can then act on the contents in the manner described. Diastase increases in activity according to the temperature, the maximum effect being produced about 160°–165° F. Its effectiveness is destroyed by boiling. The diastase is not involved in the new compounds formed by its action on starch, but seems to perform its work, as some assert, by a so-called catalytic or vibratory action, or, according to the theory now proposed, by radiant energy. But it is sufficient to know that, as

Enzymes Active in Growing Grain.

the diastase is not used up in doing this work, a small quantity with time is capable of transforming a large quantity of starch. The chemical equation showing the change from starch to dextrin and maltose is as follows:—

Hydrolysis of Starch.

$$\underset{\text{Starch.}}{3\,C_6H_{10}O_5} + \underset{\text{Water.}}{H_2O} = \underset{\text{Dextrin.}}{C_6H_{10}O_5} + \underset{\text{Maltose.}}{C_{12}H_{22}O_{11}}$$

By experiment it has been found that, if a very small quantity of diastase is used, the colour which starch always shows when mixed with iodine will disappear when about one-quarter of the liquid has been changed to sugar. The addition of more diastase causes the change to proceed until half of the starch has been changed to sugar, but the change stops there unless something is done to remove the sugar already formed. This is most easily done by fermenting it by yeast, after which the diastase present is able to continue its action until the whole of the dextrin formed at the first operation is completely changed to maltose, or, as some authorities assert, to glucose ($C_6H_{12}O_6$).

Action of Maltose on Diastase.

There is an enzyme with diastasic properties in wheat germ and in the cerealin of bran, and it is suggested that the same property is also possessed by the soluble albuminoids of rye, and to a much less degree by the soluble albuminoids of wheat flour. According to Jago,[1] the diastasic properties of the soluble proteids of flour are very weak, but, in conjunction with yeast, are capable of considerable activity in changing gelatinized starch to sugar. Amongst the enzymes excreted by yeast itself there is one credited with slight diastasic properties, but the evidence on the point is not pronounced. In any case it may be accepted that yeast does not, as asserted in some books, change the starch of flour into sugar and then ferment the sugar thus formed. Diastase acts only very slightly, if at all, on unburst starch, but its action is rapid on boiled starch, or on that rendered soluble. The change from starch to glucose can be effected without the aid of diastase by boiling the starch for a long time with a dilute solution of sulphuric acid. This is the method by which glucose is prepared on a commercial scale.

Enzymes of Bran, Germ, Rye, and Flour.

Action of Yeast Enzymes on Starch.

Action of Dilute Acids on Starch.

Invertase is the enzyme excreted by yeast, capable of changing cane sugar into invert sugar, which consists of a mixture of *glucose* and *levulose*, both fermentable sugars, but the former much more readily than the latter. The equation expressing the change is as follows:—

Invertase of Yeast.

$$\underset{\text{Cane Sugar.}}{C_{12}H_{22}O_{11}} + \underset{\text{Water.}}{H_2O} = \underset{\text{Glucose.}}{C_6H_{12}O_6} + \underset{\text{Levulose.}}{C_6H_{12}O_6}$$

It will be noted that the chemical composition of the two products of the change is the same. They may be distinguished by the facts that glucose

[1] *Science and Art of Bread-making*, pp. 218, 219.

crystallizes more readily than the other, which remains in the state of syrup, and that glucose ferments more easily. The greatest distinction, however, relates to their different effects when examined with polarized light. Glucose rotates the rays of light to the right, whilst levulose rotates them to the left. The mixture of the two is called *invert sugar*.

Action of Dilute Acids on Boiling Sugar.

Levulose is the uncrystallizable sugar of acid fruits. The same products are formed from cane sugar by boiling with very dilute acid. It is to produce some invert sugar that sugar-boilers, when making fondant and certain kinds of sweets, use a quantity of lemon juice or other acid, to prevent the mixture graining before it can be worked up. It is worthy of note that the change in cane sugar in the solution containing yeast is external to the yeast cell, and occurs before the sugar can be fermented into alcohol and carbon dioxide. Thus, if yeast is mixed with a sugar solution, and in a few minutes the solution is tested with Fehling's solution, it is found that much of the cane sugar has been changed to glucose. As already noted, this action of the invertase of yeast is preliminary to the fermentation proper, for cane sugar is not fermentable until it is thus changed. The change occurs through cane sugar, under the influence of the enzyme, taking another molecule of water into its constitution. The same thing has to occur in the case of maltose sugar or lactose (sugar of milk) before they can be fermented. A process almost similar takes place in the case

Action of Enzymes on Proteids.

of albuminoid substances. These cannot be assimilated by yeast in the natural condition, but require digesting or altering into a soluble condition like peptone. Yeast contains an enzyme capable of effecting this change, which is supposed to be similar to *trypsin* (one of the enzymes contained in the digesting juices of the stomach). The difficulty attending the study of the different enzymes is that they are not readily separated from each other, but, as with those of yeast, the enzymes excreted are probably mixed together, so that one possesses the properties of several. The trend of scientific thought with regard to the enzymes of yeast is towards showing that the whole fermentation process, including

Latest Theory of Fermentation.

the breaking up of sugar into alcohol, is the work of special enzymes, the last operation being performed by an enzyme within the cell itself, but virtually independent of the life of the cell, since sugar can be broken up in this way by this special enzyme when separated from the yeast proper. In a practical sense, however, the matter is not important, since the production of yeast is easy and safe, and its use efficient for the purposes of the baker; and the production of a liquid or powder capable of producing the same results in dough would not make matters any easier for the baker.

CHAPTER XV

THE FERMENTATION OF FLOUR

The fermentation of flour is rather a loose phrase, because much the greater part of flour is not affected in any way whatever by the action of yeast. Fermentation of dough is fermentation only of the very small quantity of sugar which it contains (1 to 1·5 per cent), with changes of a digestive kind in one or two of its other constituents. The sugar of the flour, and any other soluble matter it contains, are taken into solution by the water used in making dough. The invertase of yeast changes the sugar in solution into invert sugar, and yeast breaks this up into alcohol, carbon dioxide, and a small proportion of succinic acid and glycerine. At the same time, some of the soluble proteids of the flour are changed to peptones, &c., and are absorbed by yeast, along with some of the mineral matter of the flour, to replenish the waste occasioned by yeast producing new cells. It will be seen, therefore, that the soluble constituents of flour supply all that is necessary for yeast nourishment and growth.

What is Fermentation of Dough?

There has been some controversy on the point as to whether yeast does actually increase in dough. Since an extremely small quantity, if given sufficient time, is capable of fermenting or of aerating a very large mass of dough, and as the fermentation at the end of the process is much more active than at the beginning, there is no reasonable explanation but the progressive increase of yeast originally mixed in the dough. Against this hypothesis it has been pointed out[1] that a medium containing 14 per cent of solid matter is most favourable for yeast growth, whilst in one with a concentration of 36 per cent there is no reproduction, and as dough contains a much larger quantity of solid matter than this, therefore there can be no production of new yeast. It is sufficient to point out that the solid matter contained in the concentrated medium referred to is evidently that which has gone into solution, whilst the solid matter which constitutes the greater part of dough is not in solution, and does not affect the action of yeast at all, except in so far as it hinders the movement of yeast cells from one part to another. Direct experiments have also shown that even in dough stiffer than is generally used for bread there is a very considerable increase in the quantity of yeast during fermentation. A moment's consideration will show that there is nothing extraordinary about yeast growth in dough. The liquid part of the dough, containing all the yeast food, remains in dough as liquid; some of it goes to hydrate the gluten, some remains to encase the starch cells with films of water, containing yeast cells. Gluten in dough is in the condition of strings or fibres; the

Does Yeast increase in Dough?

Insoluble and Soluble Solid Matter.

State of Liquid and Condition of Yeast in Dough.

[1] Briant, *National Association Review*, September, 1891, p. 259.

starch cells are definite and solid. It is important to note that capillary attraction will cause the water to cling to the solid starch and along the fibres of gluten.

Spaces in Dough.

While at the beginning of fermentation the particles that constitute dough are comparatively close, yet dough is even then not dense, and in the interstices between the round starch cells there is plenty of room for the much smaller yeast cells. When these start producing gas and expanding the dough, then space may well be abundant. As the water of the dough contains all that is necessary for yeast growth, there is, therefore, nothing to hinder that growth taking place.

Reason for Kneading.

But in dough each yeast cell is practically confined to one very limited area, and as, for the reason already stated, there is probably not a flow of moisture from one part to another, each cell is confined for sustenance to the liquid in its vicinity, and can only reach that a little farther away by means of the buds which it creates. It is on this account that fermentation of dough seems practically to stop after a time, but starts vigorously again if the dough is well kneaded. In the one case the yeast, by creating gas, has pushed the source of gas production away from it; in the second case this has by kneading been brought back to contact. This is the case in a stiff dough, and to a less extent also in a slack one.

Difference between Stiff Dough and Sponge.

The conditions are different in a thin sponge and in a thin ferment. When a sponge is aerated to a moderate extent it drops, and is then in the same state as a dough after kneading—the yeast is brought back to contact with its food. The greater quantity of liquor in a sponge is likely to create a slight movement of the liquid as the sponge expands.

Movements in a Thin Ferment.

In a thin ferment the movement of the liquid gives rise to regular currents. The heat of fermentation near the bottom causes the liquid there to rise to the surface, and so the yeast, being carried along, is kept all the time in contact with its nourishment, and, on this account, probably increases at a greater rate in a moderately thin ferment than in a sponge, and more in a sponge than in a stiff dough.

Yeast Growth in Ferment, Sponge, and Dough Compared.

This is the explanation of the effectiveness of making a ferment with a small quantity of yeast, enlarging that to the consistency of a sponge, and ultimately making the latter into a dough. By this method and by that of sponge and dough only, a small quantity of yeast added at the first stage becomes a large quantity at the last, and hence, when the loaves are moulded, they prove quickly, and grow bulky in the oven.

What produces Bulk in Bread.

Bulk of bread depends largely, although not wholly, on the quantity of gas produced, and the latter on the quantity of yeast and fermentable sugar present.

Proteids in Flour assist Yeast.

The growth of yeast in dough is less dependent on the sugar in the solution than on the albuminoid matter available for food. It has been already pointed out that yeast, by means of an enzyme, can itself prepare albuminoids for assimilation as food. This process also goes on while dough

is fermenting. It is probably from the soluble albuminoids that yeast first obtains its supply of necessary albuminous food, but while dough is undergoing fermentation there is a change of the nature of peptonizing also occurring in the insoluble proteids of flour (gluten). There is not sufficient evidence yet available to show whether the change in gluten is the result of the action of the enzymes of yeast, or whether it is due to the action of acids. Either cause might produce the effects noticed, or both in conjunction.

Changes in Gluten of Flour.

The formation of acid in dough can be accounted for by the minute quantity normally produced by yeast itself, and by the action of lactic and acetic germs which may be in small number amongst the yeast, in the flour, or in the dough, from contact with old dough or utensils in which they may have been allowed to generate. That yeast has much to do with the change in gluten seems probable, when it is remembered that before it can proceed to the proper degree of softness it is necessary to ferment the dough for a long period with a small quantity of yeast, or if a short period only is allowed, then the proportion of yeast must be very much greater.

Acids in Dough.

The change in gluten is shown by certain physical changes in the dough. At first it is tough and comparatively inelastic. The elasticity increases as fermentation proceeds to the point called ripe, which there is no definite method of measuring, but which is apparent to the practical baker. Beyond this it loses its elasticity, and breaks quite short when pulled. Gluten gradually changes colour during fermentation, from yellow to grey. These three states correspond to the respective states in bread: (1) When it is tough, both crust and crumb are devoid of flavour; the latter becomes readily dry, and has a greenish-yellow colour; (2) when the crumb of the loaf is tenacious, but soft and easily masticated, has a pleasant sweet flavour, and retains its moistness till the second day, with a creamy-white colour; (3) when the crust of the loaf acquires a pale colour and is hard, the crumb being of a bleached-white or greyish colour, dry and crumbly, quite flavourless, or else with a tendency to sourness. The texture and shape of bread improve in proportion as the gluten is properly ripened.

Physical Changes in Dough.

Conditions of Unripe, Ripe, and Over-ripe Bread.

Gluten undergoing this change gradually loses its property of insolubility and becomes soluble. It is a nice point whether all the gluten is softened to an increasing extent while the fermentation is proceeding, or whether succeeding small portions are affected so as to become entirely soluble while the remainder of the gluten is insoluble as at first. The former view is most probable, and best explains observed phenomena. Experiments bear this out.

Does Gluten soften Wholly or in Part?

CHAPTER XVI

METHODS OF BREAD-MAKING: LONG-PROCESS STRAIGHT DOUGHS

Twelve-Hours Dough

Very few flours will bear to be fermented in straight dough for twelve hours, counting from the time dough is made till it is thrown out on the table to be weighed into loaves. The reason is, of course, that the gluten softens very much in that time, and in the case of soft flours will reach the stage of shortness bakers call rotten. To make allowance for the softening effects in any case, it is always necessary to make long-process doughs very stiff—so stiff that when cut over in the trough the cut surface will stand quite rigid without slipping, almost like a hard biscuit dough. When this comes to be worked up at the end of the period mentioned, it will be found soft and pliable enough, with a good deal of elasticity still remaining, and will produce a bulky loaf but with a flavour not unlike that of a loaf made on the sponge system. For a dough of this kind the following quantities should be used: 280 lb. flour (a strong flour, or a mixture containing 11 per cent of dry gluten), 6 oz. yeast, 4½ lb. salt, 6 oz. sugar, 13 gal. (130 lb.) water of a temperature to make dough about 76° F. The quantity of salt here given is more than is generally required; but this quantity, or in some cases ½ lb. more, helps to prevent the gluten of the flour from becoming too much degraded. The quantity of water will produce tight dough, and this may seem uneconomical, as the yield will be comparatively small. This is compensated for to some extent by the small quantity of yeast used. The loss is not so great in any case as may at first sight appear, for loaves from dough of this type will not lose so much weight in the oven, nor so much after leaving the oven, as will those made from much slacker dough on a short process. The bread will actually eat moister after it is a day old than will that from soft dough, not so much because of the quantity of water it contains, as because of the state of the gluten. The temperature here given is comparatively high, yet it is necessary in fermenting dough, even for a long period, to ensure that its temperature is high enough to allow the yeast to continue working at a slow but steady rate. It happens not infrequently that the temperature is kept too low, the purpose being to make it work very slowly, so that the dough may not be over-ripe; but the opposite extreme may be reached, and the dough be much under-ripe, because the yeast has been nearly stagnant all the time. This may readily occur if the temperature of the dough is kept under 70° F., unless the bakery is very hot while the dough is standing.

Limits of Straight-Dough System.

Stiffness of Long Straight Doughs.

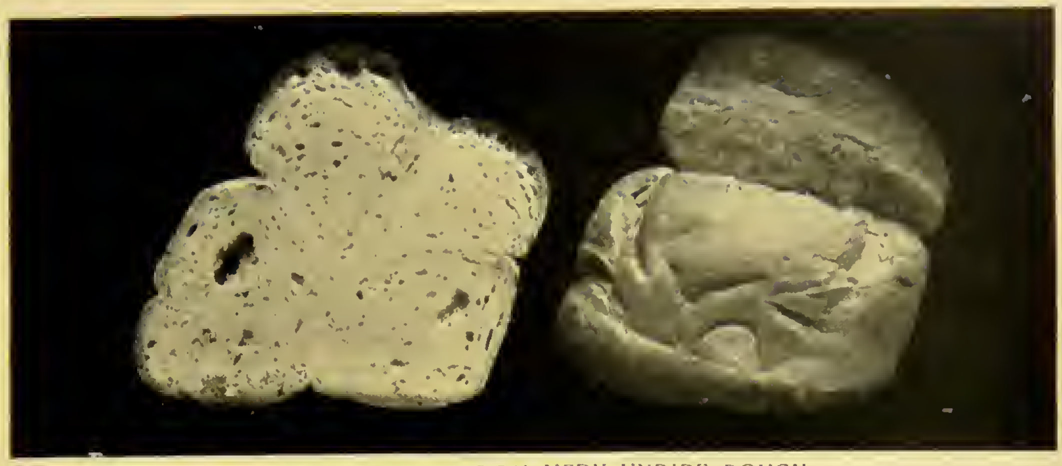
Flavour and Bulk of Bread.

Quantities for Twelve-Hours Dough.

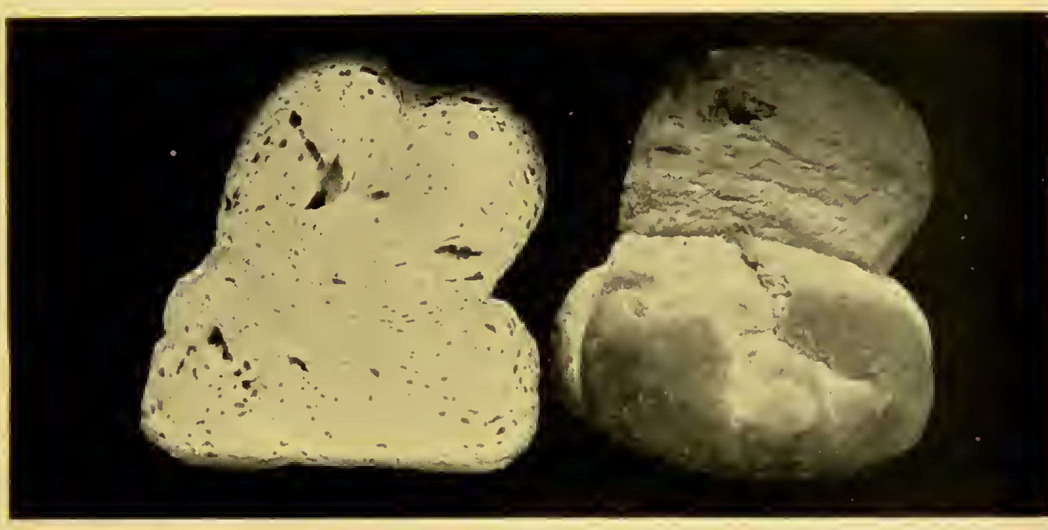
Are Long Doughs Economical?

Moistness of Breads compared.

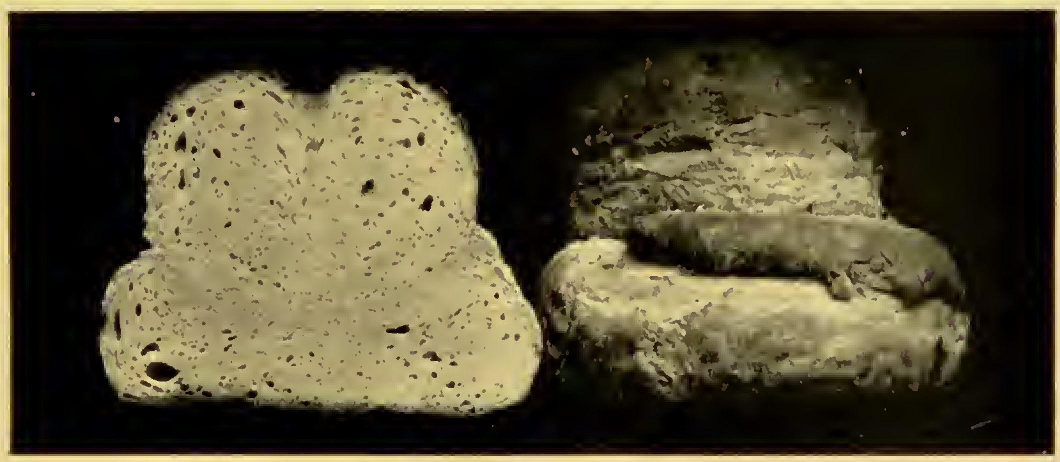
Long Doughs often unripe.



COTTAGE LOAF FROM VERY UNRIPE DOUGH



COTTAGE LOAF FROM UNRIPE DOUGH



COTTAGE LOAF FROM UNRIPE DOUGH

COTTAGE LOAF FROM QUITE RIPE LOUGH

 STAGES IN FERMENTATION OF A CRUSTY LOAF

Causes of Unripeness.

The unripeness is the result of two causes. The original yeast used does not produce either enough gas or sufficient softening effect on the gluten of the flour, and it does not create sufficient new yeast to make fermentation active at the stage at which activity is specially desired, viz. when the loaves are proving after moulding, and before placing in the oven, as well as for some time after. In the case of crusty loaves, such dough produces those that are small and unshapely, very close in centre, more open at top and bottom, but usually drawn into large holes at the top. The Plate Stages in Fermentation of Crusty Loaf shows loaves at increasing stages of ripeness, the last being just right.

Temperature of Dough.

Rough Temperature Calculations.

The temperature stated is that of the dough when finished making; and as this is the first description of dough-making, it is necessary to give an easy method of at least roughly ascertaining the temperature the dough is likely to be from the temperature of the water used, as water is the only factor the baker has readily under control in this operation. The simplest method, and one easily remembered, is to double the temperature you require the dough to be, and subtract from that the temperature of the flour; the answer will be the temperature required for the water. Thus, in the dough given above the temperature wanted is 76° F. Suppose at the same time that the temperature of the flour is 66° F.; then the necessary temperature of the water would be found thus: 2 × 76 or 152 − 66 = 86. Accordingly, to obtain dough at 76° in such circumstances, we should use water at 86° F. The method is not always accurate, but is roughly so.

Another Method of Calculation.

Finding the "Major Factor".

Depending on the same principles, there is another method of arriving at the temperature necessary for the water by the use of a fixed factor. This factor is first obtained by experiment in this manner. On several occasions careful note is taken of the respective temperatures of flour, water, and the air of the bakery. If on those occasions the resultant bread turned out quite satisfactory, these temperatures are added together, and this becomes the fixed or major factor, the correctness of which dominates the whole calculation. Thus, in the example just given the temperature of the flour was 66°, of the water 86°, of the air of the bakehouse, say 68°. Assuming that these conditions produced satisfactory bread, then they might be used for finding the fixed factor thus: 66 + 86 + 68 = 220. As long as the twelve-hours dough system was in use this figure would be kept always in mind. On any occasion on which it was required to find the necessary temperature of water for dough the two other lesser factors would be added together, and their sum subtracted from the fixed factor; the result would be the necessary temperature of the water. Thus, suppose the flour had fallen to 60° F., and the temperature of the bakery to 62°, then the sum of these, 60 + 62 = 122, is subtracted from the fixed factor 220, leaving 98° as the temperature of the water.

In a long process it is necessary to take note in this way of the temperature of the air of the bakery, since it has such an influence on the temperature of the dough while it is lying in the trough, generally during night, because with such a small quantity of yeast the chemical energy generated within the dough is not sufficient to make up for the loss of heat to the air. But when a short process with a large quantity of yeast is adopted, considerable heat is generated, and the dough is such a short time in the trough that the cooling effect of the air on the dough is not very pronounced, even when the difference in temperature between them is several degrees. In the latter circumstances, therefore, the temperature of the air may be disregarded, and the fixed factor is then made up only of the temperatures of the flour and the water. Reverting again to the example given, the fixed factor in this case would be 66 + 86 = 152. To find, then, the necessary temperature of the water for dough on any day, it is only necessary to subtract the temperature of the flour on that day from the fixed factor, and the remainder will be temperature of the water. Thus, if the flour had fallen to 60°, as already suggested, then the water should be 152 – 60 = 92° F. It must be understood that these figures are not given as those that should be adopted, but are merely examples to show how this system works. In every case the fixed factors should be found in the manner shown, and may differ considerably for different bakeries.

Influence of Heat of Atmosphere.

Influence of Quantity of Yeast in maintaining Temperature.

Experiment the only Basis of System.

Six ounces is a very small quantity of yeast to be used in such a large mass of dough, and it can only do the work efficiently if it is very evenly mixed. To ensure this, it must first be carefully broken down in a small quantity of water, and then thoroughly mixed in the whole water. Holes in bread may be caused by little pellets of yeast which have not been broken down. The addition of the small quantity of sugar here given is helpful in the production of gas. As the proportion of acid-producing bacteria is probably greater in this dough than in a short-process one, these assist in its ripening.

One Cause of Holes in Bread.

Acid Matter probably useful.

When dough is hand-made, the essential thing is to prevent the formation of scrap. This is attained by drawing in the whole of the flour necessary, and shaking up well before actually making dough. As dough is very tight, it requires, while making, to be cut in small pieces, from one end of the trough to the other, at least three times. Should there be any scrap left, it is better to moisten it with water and make it into a soft dough before mixing with the batch. To make a dough of this size and this kind a man will take about forty-five minutes, but a machine could do the work equally well in ten or twelve minutes. The time allowed for dough to lie is from the time it is made to that when it is thrown out on the table to scale, and the assumption is that about one and three-quarters to two

Good Dough-making.

Time required to make Dough by Hand.

hours will be sufficient time for the bread to be finished baking, so that what is here called a twelve-hours process is fourteen hours if the time is counted from the time of dough-making till baking is finished. As the manipulation and baking of loaves will occupy a short time where a large staff is employed, and a comparatively long time where one man has all to do, it is evidently necessary to let the dough lie a little longer in the trough in one case, and a shorter time in the other. The twelve hours here given may be taken as the mean time. With those reservations, it is assumed that the dough will be thrown out on the table for scaling in twelve hours; but it would probably not be ripe enough then if it had not been kneaded at least once, or, better, twice while it had been standing. When it has been lying altogether ten hours, it should be cut in pieces and turned from one end of the trough to the other, and well kneaded. The kneading operation should be repeated in another hour's time; but dough need not be cut back, only well kneaded, and four sides folded up. Machine-made dough ought not to require cutting back at all, but it requires kneading like the other.

Definition of Length of Process.

"Cutting Back" and Kneading.

Long processes are most suitable for crumby bread. When dough is scaled, it should be "handed up", preferably into boxes. The time occupied in weighing, especially where only a small staff is employed, is sufficient to allow the loaves to stand at this stage, so that as soon as weighing is completed, moulding should be started at once. After moulding, it is best to allow ten or fifteen minutes to elapse before "setting" in the oven, especially if the loaves are close packed and crumby. Such a long system is not very suitable for crusty loaves, as they incline to flatten out while proving. Bread baked on this system has a flavour characteristic of that made on the long systems of Scotland and Ireland.

Time to Stand on Board.

Eight-Hours Dough

For a dough to stand eight hours in trough the following ingredients may be used: 280 lb. medium strong flour, 11 oz. yeast, 4 lb. salt, 12 oz. sugar or glucose, 13½ gal. water. The precautions suggested in dealing with twelve-hours dough apply with equal force to one intended to stand eight hours. This also requires to be stiff and well made. The quantity of salt is still a little above the quantity used in a short-process dough, because of the softening of the gluten.

Eight-Hours Dough.

Glucose, here suggested as an alternative to sugar, can be obtained in either the liquid or the solid form. On account of the stickiness of the former, and the consequent trouble in handling, solid glucose, known commercially as "Buffalo Chips", is more suitable for bakers' use. It can be weighed in quantity for each batch, and then dissolved. It does not readily dissolve in cold water; but if placed in a measured quantity of cold water, and then placed in the oven or over a stove, it readily dissolves to a clear yellowish liquid, which, when cooled, can be mixed with water for dough in the usual way.

Use of Glucose in Dough.

Mode of using Glucose.

Glucose is a little cheaper than sugar, and is more effective in starting a vigorous fermentation and in giving the bread a nice bloom. When a long process is followed, it is better to use sugar or glucose than malt extract or malt flour. Both the latter substances are dearer than the former, and they rather intensify the softening effects on gluten. Any flavour which they may impart to the bread is effectively masked by the blending of other flavours generated during fermentation. The dough requires to be cut back when it has lain seven hours, and it is thrown out and scaled in one hour more. It is then worked up in the way already described for the longer process. This dough is quite suitable for upstanding crusty bread, for although it proves quickly on the board, it is still tough and stable, and produces plump bulky bread if the flour has itself been stable—say, containing about 11 per cent of dry gluten. The main difficulty about making bread by a process of this length is, in the case of overnight doughs, that the man who makes it has to be at the bakery at a late hour, say 9 p.m., and again at 4 a.m., thus seriously interfering with his leisure and rest. In the case of doughs standing in the daytime, it could only be suitable for the last batch, and this would occupy too much trough space during the day. Otherwise, excellent bread, which keeps moist, can be made on this system.

Eight-Hours Dough for Crusty Bread.

Difficulty with Long Straight Doughs.

Six-Hours Dough

Quantities for Six-Hours Dough.

For a dough to stand six hours in the trough use the following quantities: 280 lb. flour of medium strength, 1 lb. yeast, $3\frac{3}{4}$ lb. salt, 8 oz. malt flour or malt extract, $13\frac{3}{4}$ gal. water. This dough will not be quite so stiff as the last, and as the softening effect will not be so excessive, the quantity of salt is reduced by 4 oz. There is no yeast food actually needed beyond that naturally in the flour, but, especially in short-process doughs, it is usual to add saccharine matter of some kind to quicken fermentation and to increase bloom on loaves or to improve flavour. For this latter purpose malt, or some mixture of which it forms a large proportion, is generally used; and as malt extracts are rather nasty to handle, besides being liable to adulteration with ordinary glucose, malt flour is the better substance to use. Although this is darker than flour, it does not appreciably darken bread. It may be used by simply mixing with the liquor for dough, but in this way the minimum effect of its use is obtained in the matter both of diastasis and of flavour. To enhance the effects without using more of the malt flour, it should first be mixed with some scalded flour or scalded corn flour. For a one-sack batch 1 lb. of scalded flour may be used. It is first mixed into a thick smooth paste with about 3 pints of lukewarm water, then about 5 pints of boiling water are added, and the whole stirred vigorously. The boiling water should be added 1 pint at a time, stirring well after each addition to prevent

Malt for Flavour.

Method of using Malt Flour with best Effect.

lumps forming. When finished, this mixture will be a thin paste, rather brown in colour, and at a temperature of about 180° F. When it has cooled to 170° F., the malt flour or malt extract is thoroughly mixed with it, and the whole allowed to stand for about an hour till its temperature falls to 100° F. This quantity will be found quite sufficient for a sack batch to stand six hours in dough, and will hasten fermentation and increase the yield of bread, besides giving a pronounced malty flavour. The method may be followed whenever malt flour or malt extract is used. It produces maximum effects with the smallest quantity of material.

Six-Hours Dough.

A six-hours dough may be regarded as the longest of the short-process methods. It is suitable for use in those situations where dough is made, say, at ten o'clock at night, and work starts at four in the morning; or it is convenient where a dough may be wanted for second or third batch, and is made first thing in the morning. By this method very sweet and bulky bread is obtained with the natural flavour of fermented flour, unaltered by the other flavours produced by bacteria. This dough requires to be cut back and kneaded about an hour before scaling, and should also have proof knocked out of it immediately before being taken from the trough. The loaves require no special treatment on the board. If the system is intended for crumby bread, it is desirable to use 4 lb. salt, and to take dough half an hour sooner, as the loaves continue working longer after setting in the oven than crusty sorts; if allowed the longer time, and given full proof before setting, they are likely to be dry and crumbly.

CHAPTER XVII

METHODS OF BREAD-MAKING: SHORT-PROCESS STRAIGHT DOUGHS

Five-Hours Dough

Five-Hours Dough.

For dough to stand five hours in trough the following may be used: 280 lb. flour, 3½ lb. salt, 1¼ lb. yeast, 12 oz. malt flour or malt extract, 14 gal. water. The temperature of the water should be such as would make dough 80° when finished. This dough would be about normal stiffness for crusty bread, containing half its weight of water to flour used. Dough softens considerably while lying, but recovers its toughness and stability on kneading. It is better to be cut back and well kneaded about three hours after making, and again kneaded well just before scaling. The quantity of salt used is also normal, and should not be reduced, whatever process is followed, for its influence as a flavouring agent, apart from its steadying effect on fermentation, is at its best when 3½ lb. per sack is used. Malt flour and malt extract are best used in the manner described for six-hours dough.

Four-Hours Dough

Although six hours has been mentioned as the longest of the short processes, a dough standing four hours is the longest that is usually called short.

Four-Hours Dough.

A dough to stand four hours in the trough should consist of the following: 280 lb. flour, $1\frac{1}{2}$ lb. yeast, 12 oz. malt flour or malt extract, $3\frac{1}{2}$ lb. salt, 14 gal. water. The temperature of the water should be such as would make dough of 80° F. when finished. With the quantity of yeast used, the temperature of the dough will rise during the first two hours of fermentation to about 86°, and will recede again to 80° when the dough is about ready. This process is that generally adopted in large bakeries where doughs are made in the evening just before general work starts, the dough-making being done by a special man who begins a few hours before the others, and makes doughs to be taken in succession at regular intervals. The dough should be cut back and well kneaded about one hour before scaling. As the dough is under observation and control all the time fermentation is proceeding, the system lends itself to great regularity, if every process is conducted with care and the thermometer is in constant use. Bread thus produced is sweet and moist and of fair bulk. It works quickly on the board, and requires no waiting between scaling and moulding, although, to obtain bulk it is better to allow a few minutes between moulding and setting in the oven, unless the staff is very small, when it requires to be dealt with at once.

Three-Hours Dough

Three-Hours Dough.

For a dough to stand three hours the ingredients should be as follows: 280 lb. flour, $1\frac{3}{4}$ lb. yeast, 1 lb. malt flour or malt extract, &c., 14 gal. water, $3\frac{1}{2}$ lb. salt. The temperature of the dough in this case when finished should be about 82° F. It will rise during the first hour and a half to about 88° F., and will fall again to 82°. It is kneaded one hour before scaling. The loaves prove quickly on the board, and only require a few minutes after moulding before setting. Moderately bulky and sweet bread may be made by this method, and it has usually a very nice bloom. The comparatively large quantity of yeast makes it necessary to handle the dough smartly; otherwise there is danger of the bread becoming crumbly and dry.

Two-Hours Dough

Hazard with very short Doughs.

Two hours is about the minimum time in which dough may lie in the trough to produce satisfactory bread on a commercial scale. There is no difficulty in making excellent bread on even a shorter system, but the large quantity of yeast necessary works so quickly, that, unless a large staff is employed to handle the loaves,

there is much irregularity amongst them. For a dough to stand two hours in trough the following quantities are used: 280 lb. flour, 2½ lb. yeast, 3½ lb. salt, 1 lb. malt flour or malt extract, 14 gal. water. The temperature of the water should be such as to make the dough 82° F. when finished. This will rise to a little over 88° in the centre of the dough during the first hour, and recede again to about 82°. The dough should be cut back and well kneaded after it has lain one hour, and proof knocked out of it before scaling. The latter operation should be done only if the dough is slightly under-ripe, as, with one containing so much yeast, there is a danger of its being exhausted, and although seemingly lively enough, it fails to attain any bulk either on the board or in the oven if it is knocked back when in this condition.

Exhausted Dough.

One-Hour Dough

As already noted, this time is really too short for a commercial dough, but occasions do arise when it is necessary to make a batch of bread in a hurry. Then the following quantities may be used for a dough to stand in the trough one hour: 280 lb. flour, 4 lb. yeast, 3½ lb. salt, 1¼ lb. malt flour or malt extract, 14 gal. water. If the bread is to be crusty, it is not safe to make dough any slacker than this quantity of water will make it; otherwise it gets rather out of hand before it can all be worked up. In this case, even more than in the last, there is a danger of the dough becoming exhausted, and producing small and unsatisfactory loaves in consequence. The yeast keeps working even after the bread is placed in the oven, and to make allowance for this, it is better to take the dough rather "green" than over-ripe. The temperature of the dough when finished should not be above 80° F. The bread when baked is sweet and bright-looking, but in many cases, for the reason stated, viz., the exhaustion of the dough, complaints are made that it becomes quickly dry. Bakers who have not before used so much yeast in dough are sometimes afraid that the bread will be yeasty in taste, but this is not the case. Loaves from this dough are best baked in a comparatively warm oven, say about 450° F. One peculiarity is that when cut this bread eats short like cake, especially when one day old.

Shortest System.

CHAPTER XVIII

METHODS OF BREAD-MAKING: EXHIBITION BREAD

It has become so much the fashion for bakers in all parts of the kingdom to enter for exhibition competitions in London and elsewhere, that it seems necessary here to include a description of the methods whereby the best results for competition bread may be obtained. As loaves for this

purpose have generally to be made along with a batch of ordinary bread, it is more convenient to make small rather than large quantities of dough.

Small Doughs most suitable.

The former can be weighed and moulded in a few minutes, so that all the loaves prove in about the same length of time, and they do not seriously interfere with the working of the ordinary bread; but if large lots are made the work of the bakery is disorganized, and the large quantity of yeast in the dough causes the loaves to prove so quickly, that the first may be overproved while the last is not proved enough. For a very small batch, then, the following quantities may be used: 10 lb. flour (high-class English patent), 2 oz. yeast, 2 oz. salt, $1\frac{1}{2}$ oz. malt flour, $4\frac{1}{2}$–5 lb. water. The temperature of the water should be such as to make the dough when finished 82° F. Dough is made straight off, and with as much expedition as possible, to prevent its cooling overmuch. The dough should be very well made, without scrap. A matter of great importance is to keep it in a situation the temperature of which is about the same as the temperature of the dough itself.

Mode of Handling Dough.

If it can be obtained, the best thing in which to keep the dough is an enamelled basin. A dry cloth should cover the dough, with a damp one on the top of it. The dough should lie just one hour, and then be thoroughly kneaded, if necessary being cut in small pieces, and each kneaded separately for the first time. It is then allowed to lie for a half-hour, and again kneaded, all in one piece this time, folding the four sides in, and knocking the proof quite out of it during the operation. The kneading process is repeated at intervals of half an hour until the dough has lain for three hours from the time the yeast was mixed. It should then be in condition for scaling.

The kneading operation is probably the most important of all as a means of obtaining a fine texture.

Cause of Fine Texture.

The progress of texture-making can be easily seen in the dough, if it is cut after kneading with a sharp knife. If the bread will be holey, those holes will already be apparent in the dough; if the texture is fine in the dough, it will be fine in the bread; if the texture is not thoroughly made at the dough stage, it is not possible to make it in moulding, especially in round shapes. If fine texture is made by kneading, moulding can be very gentle. When the loaves are weighed, they should be "handed" or "balled" up, and allowed to lie in this condition for about ten minutes, until the spring has left the dough; otherwise the skin will crack badly at moulding. When a large batch is being handled, it is not necessary to wait at all between handing up and moulding, as the operation itself occupies sufficient time to allow the first of the loaves to be ready for moulding by the time the last are handed up. The mistake is frequently made of allowing too much time at this stage, with the result that a quite lively dough may make very disappointing bread.

When Moulding should be done.

Dough with this large quantity of yeast is fermented nearly enough while in trough, the time the loaves take to prove being just sufficient to complete the ripening process. But if loaves stand a long time between scaling and moulding, they are ripe enough before being moulded at all, the dough is

almost exhausted, and after moulding it refuses to prove properly, and the loaves come from the oven small and close.

When loaves are moulded they should be topped at once if for crusty cottages, but not bashed until they have recovered from moulding. This may not take more than about four or five minutes. The loaves should then be firmly and steadily pressed with the heel of the hand, and then indented in the centre with three fingers and the thumb, held in the form of a plug. Care should be taken that the loaf is standing quite straight and upright when bashed, and that the top and bottom are in proper position. Proof should then be allowed to proceed at a temperature as nearly as possible the same as that of the loaves themselves, and should take from forty-five to sixty minutes. If proving can be done in close boxes or drawers, where there is no draught, and consequently no danger of skinning, it is not necessary or advisable to put any covering whatever on them; but as this is not always possible, it is best, when proving has to be done in the open, to cover with a piece of fine dry cloth, and on top of that a wet piece. When loaves are of the Coburg type (Plate ENGLISH CRUSTY BREAD, fig. 4), they may be very conveniently proved upside down on dry cotton cloths, on which no dust whatever is required. The skin next the cloth keeps fine and moist in this case, and as the loaf is turned over before being cut, this fine skin is uppermost in the oven. Coburgs do not require to be proved quite so much as cottages. They should be cut and placed in the oven before full proof; then they spread out better, and the fresh dough, springing in the centre, gives them the bright look, produced by the different shades of colour of crust, which is so desirable.

"Topping" and "Bashing".

"Proving."

Proving on Dry Cloths.

Points of Brightness in Coburgs.

If the exhibition bread is for "tins" (Plate ENGLISH CRUSTY BREAD, fig. 6), then the same quantities of materials, except in the case of water, may be used. The water should be at least half the weight of flour. This, with sufficient proof after moulding, will give an even texture of crumb, but to obtain a desirable brightness, it is better to use 5½ lb. of water to 10 lb. of flour. In all respects the same care should be exercised in making and kneading dough as in the case of crusty loaves. Although the same proportion of yeast may be used as in the former case, it is better to start scaling at the end of two and a half hours from the time of dough-making, instead of three hours. The purpose of this is to allow for a better proof in tins than in the case of cottages, which is possible without damage to shape, as the tin confines. In ordinary circumstances, tin loaves made on this method will require about one hour to prove, the condition being that the temperature of the situation is as nearly as possible the same as that of the interior of the loaf. If it is warmer, there is danger of the loaf being too open all over, and probably crumbly; if it is colder, the loaf is likely to have a band of close texture of greater or less thickness all round the sides, and to be much more open

Exhibition "Tin" Bread.

Shorter Dough Process.

Close Band around Tin Loaf.

in the centre. Tins should be well greased on the sides, not only to prevent the loaves sticking—which requires very little grease—but to assist in giving them a nice bloom on the sides. For the same purpose black steel pans are much more effective than tinned ones, the reflective properties

Black Tins better than Clear.

of the latter preventing the heat from baking the crust so readily. On this account loaves baked in clear tins have often a soft pale crust, whilst those in dark tins have a nice bloom and are crisp. This result can be obtained to some extent also with clear tins, after they have been in use for some time and have become dull, or even when quite new if the outside of the tin is well painted over with lampblack before use. To prevent tin loaves cracking on top after being drawn from the oven, the expedient may be adopted of slightly greasing the tops of the loaves with a little melted lard, or, better still, with fine oil.

Crumby Batch Loaves.

The dough used for tin bread will serve very well for crumby loaves for exhibition purposes. In this case, however, 5 lb. of water would be the proper quantity to use with 10 lb. of flour, and, to obtain a nice pile on the loaves, it is better to use 2½ oz. of salt instead of 2 oz. These loaves may, like the cottages, stand three hours in dough before scaling, receiving, of course, the same amount of kneading. They need not lie between handing up and moulding any longer than is necessary to allow the dough to lose its toughness. It is a mistake to set even crumby loaves without allowing them some proof, although it may not be for more than, say, twenty minutes, for this class of bread continues to prove in the oven for a longer time than crusty loaves.

How to handle a Small Lot of Crumby Bread.

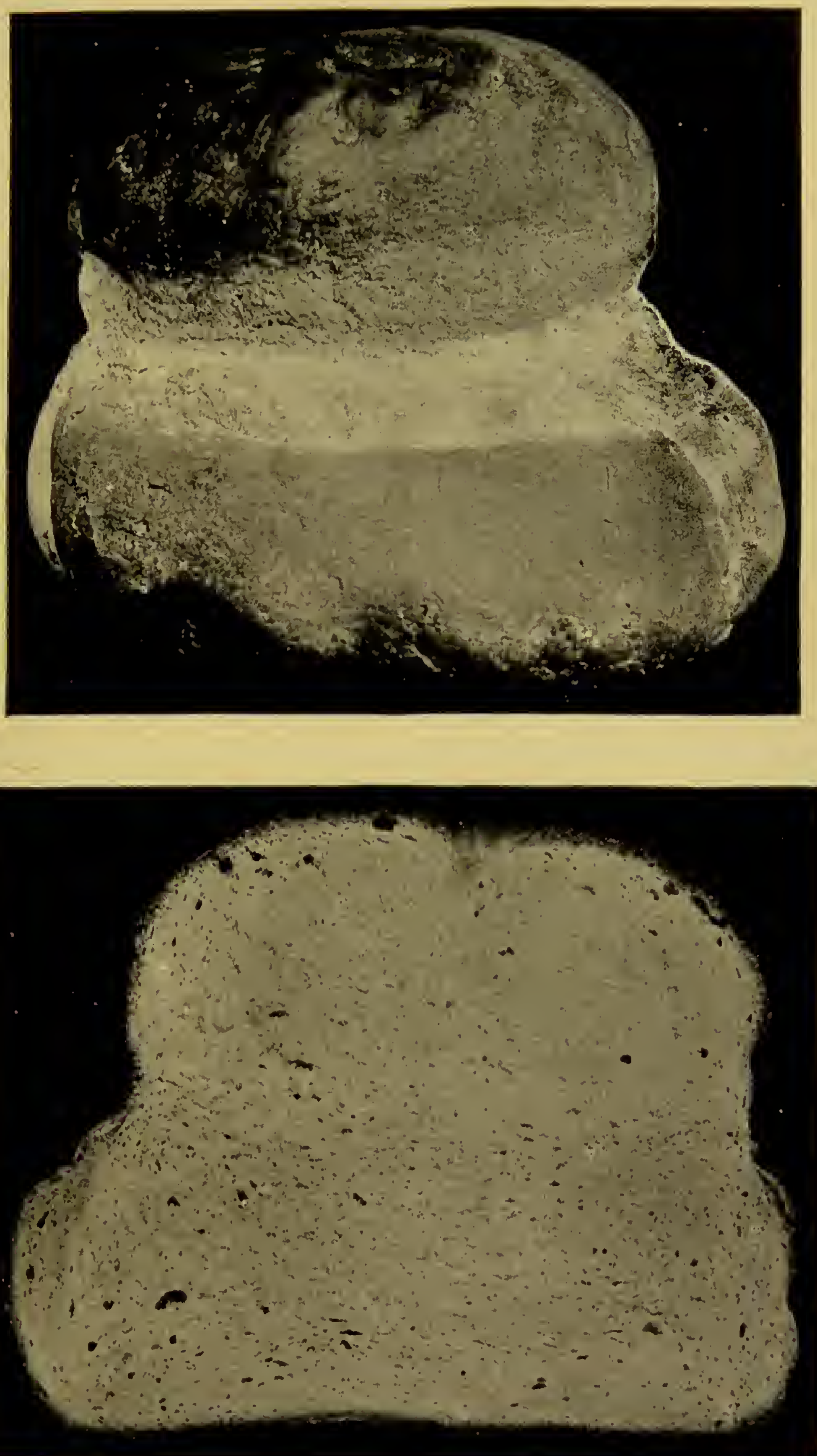
In most cases there is difficulty in getting crumby loaves for exhibition purposes, because few bakers now make large batches of that sort. If they are baked on a tin, the outside loaves incline to be higher on the inside than on that next the "upset", and the latter also draws the inside loaves attached to it over towards the side, thus spoiling the square and upright appearance which such loaves should have. If a baking sheet must be used, it is really better to place only three loaves across rather than four, and to allow each sufficient space longways, that it may be quite square, for if the loaves are set too close, they are necessarily also high, and the drawn-over appearance is intensified. But a much better plan than baking in

Baking with Upsets.

this way is to make a square about the centre of the oven with wood upsets, 5 in. high, and about 1¼ in. thick. This square may be about 2½ ft. long, and the same wide, internal measurement. The upsets can be supported on the outside by bricks, and may be greased and floured, or else well chalked on their inside surfaces. This space will hold six rows of six loaves, and if they are set neatly, the inside ones should be good specimens, and will be all the better for being baked directly on the oven bottom.

Moulding Batch Bread.

When moulding this kind of bread, the top and the bottom of the loaf should be of exactly the same size, but some bakers make the top part slightly the larger of the two. They should be proved in boxes, and each loaf



PRIZE COTTAGE LOAF

(9)

greased with melted lard round the sides, doeked on top, and washed over with a little milk. They are all the better for washing over with milk a second time just before setting in the oven, then with water or a little oil when drawn.

Baking Bread.

The critical operation in making exhibition bread is that of baking, particularly in the case of "crusty eottages". When only a small batch is made, as here suggested, it is best to have the loaves ready so that they may be baked with an ordinary bateh, and in a position in the oven where the heat is equable. They are then protected by the other loaves from excessive heat in any one direction, and the atmosphere of the oven is also quickly filled with steam, thus producing an ideal condition for the perfect baking of the loaves. But the mistake is not infrequently made of turning an excess of steam from a boiler into an oven full of cottage bread, with the result that the tops are unduly softened and flatten out; then, when a crust is formed, there is a sharp ring all round the top part of the loaf, which is objectionable. It is not always possible to get these small trial batches ready with the ordinary bateh. Recourse has then to be had to expedients that produce conditions somewhat similar to those whieh obtain under ordinary work. When a very small quantity of crusty cottage bread is plaeed in the oven by itself, the tendency is for the erust to form very quickly on the top, and generally on the sides nearest the greatest sources of heat; this, too, before the loaves nearly stop growing. The crusted part remains rigid, while the soft parts continue stretching, with the result that the loaves are frequently twisted very much to one side, and internally contain holes, especially under a crust that has been formed very quickly. Under such circumstances, therefore, it is usual to protect small batches in one way or another. The simplest expedient is to make a square in the oven, of size suffieient to hold the number of loaves in the batch, with loaf pans, filled with wet sawdust—this is better than water only; then set the loaves neatly in this square, and, if the oven is hot on top, place a sheet of thick brown paper on the top of the loaves. This can easily be done with the peel after the loaves are set. As the loaves soon dry on the outside, there is no danger of the brown paper stieking; and it has no repressive weight, but is a comparatively efficient non-conductor. It is carried along with the loaves as they spring, and should be removed as soon as they have grown to the full height and are set. This can easily be done with the peel, or a more convenient way is to have a piece of string attaehed to the paper, with which it ean be drawn off and out of the oven when necessary. These expedients protect the loaves effectively, and allow them to spring at a gentle and steady rate, keeping them straight, if they were in that condition before being placed in the oven.

Effects of Excessive Steam on Bread.

Small Batches baked alone.

Expedients to prevent Twisting.

Oven Door open.

Instead of using paper to cover the tops in this way, it is effective, still using the tins with sawdust, to bake the loaves for the first fifteen minutes or so with the oven door open, and keeping

them as near the front as possible. Another plan, instead of protecting all the loaves in a small batch, is to protect each one singly. This is easily done by making a collar about 6 in. deep, and, say, 7 in. in diameter, of brown paper, and covering the top with another piece. Each loaf is covered with one of these paper boxes, which must be removed shortly before the loaves are quite finished baking, so as to allow them to take some colour. An expedient of this sort is, of course, only possible when a few loaves are being baked in an empty oven by themselves. When they are baked along with a large batch, the same protection is afforded by merely placing a sheet of thick brown paper on the top of those which are intended for exhibition purposes.

Protecting Loaves singly.

There has recently been placed on the market a deep steel box with cover for the purpose of baking crusty cottage loaves, so as to ensure that the tops will not be twisted over. This box ensures the same kind of protection from heat as the brown paper, but, on account of the better conductivity of iron, the loaves become quite baked within the box, the crusts acquiring their proper colour, and as the steam is not allowed to escape, they also become glazed; but while this is an advantage in the matter of appearance, it causes the crusts to become soft and tough when the loaves are a few hours old. To remedy this fault it is necessary, when the baking is done in such a box, to finish for the last ten minutes with the lid off.

Exhibition Boxes.

As a simple expedient for keeping the tops of cottages straight when baking is done in the ordinary way, "notching" is usually resorted to. The efficacy of this is due to the inside of the notches remaining soft, and allowing expansion of the top laterally, instead of the gas being imprisoned with the hard crust and forcing the top to expand only vertically. When "tin" loaves are intended for exhibition purposes, they should be slacker in dough than cottages, and proved only to about three-quarters of the size they are wanted to be. Then they should be baked as wide apart as possible, or, at least, wide enough to allow the heat to get well at the sides of each. The oven should not, however, be above 440° F.; if more, the tops of the tins should be protected with brown paper in the manner already suggested for cottages. In an oven at this temperature fermentation continues for some time in the oven; hence the advisability of getting them in before being proved to their utmost, to prevent crumbliness.

Effects of Notching.

CHAPTER XIX

CRUSTY LOAVES: NAMES, SHAPES, AND METHODS OF HANDLING

Hitherto only straight doughs of long and short processes have been dealt with, and, as those processes are most convenient for crusty loaves, it will be well at this point to indicate a few points of importance regarding names, shapes, and method of handling.

TYPES OF ENGLISH CRUSTY BREAD

1. Crusty Cottage.
2. Crusty Brick.
3. Twist or Collas.
4. Coburg.
5. Small-top Cottage.
6. Tin.

TYPES OF ENGLISH CRUSTY BREAD

In all English-speaking countries where crusty loaves are made there is a certain agreement as to what is a *cottage loaf*, the English cottage (Plate ENGLISH CRUSTY BREAD, fig. 1) being generally accepted as the standard in this matter, but the method of manipulation varies in each district. In London the practice is to make the top of the cottage about one half the size of the bottom part, and in most cases "closings" of both parts are placed downwards, although some prefer to place both closings together in the centre of the loaf. This is always done in a characteristic London loaf called a *small top* (Plate ENGLISH CRUSTY BREAD, fig. 5), which is moulded lightly, in cones or flour, and the closings of the bottom part of the loaf are intended to open out and show cracks on the upper surface of the bottom part when baking in the oven, the top being exceedingly small, say about one-fourth the size of the bottom. When loaves are newly moulded, in the case of ordinary cottage, the tops should be at once placed in position on the bottoms. This is not always done; some bakers think they get better results by proving the parts separately, then topping and bashing just before they are set in the oven. The trouble arising from this method is that the parts may become skinned, or even unduly cooled; then at the point where they subsequently come together there is very likely to be a dark-coloured streak of much closer texture than the remainder of the crumb. The same fault may be found if the parts have been proved in too thick a layer of cones, which adheres, and in this case the streak will have a leathery toughness that is very unpleasant. If a broad, dark band appears in the centre of a cottage loaf, this is not infrequently caused by the loaf being insufficiently baked when drawn from the oven and sagging into closer texture afterwards. Some bakers do not allow any appreciable proof on the loaves after moulding, but start at once to set in the oven, the general practice being for one man to continue moulding while another man, as soon as a sufficient start is made with the moulding, sets in the oven. By this method each loaf after moulding does not stand more than about three minutes until it is in the oven. When this is done, the loaf, before being placed on peel, is bashed right down, sometimes with the whole fist. The result of such treatment is that the loaf is quite close, almost pudding-like in the centre, but open in texture for about $\frac{3}{4}$ in. from the bottom, and again for about $1\frac{1}{2}$ to 2 in. from the top. The latter part has a drawn-like appearance, with several irregular holes near the sides. This excessive bashing is found to be necessary, when loaves are set so quickly after moulding, to prevent the tops being thrown quite off, but its effect otherwise is very unsatisfactory.

Cottage Loaves.

Small Tops.

Proving Parts separately.

Cause of Streaks in Cottage Loaves.

Bashing that Spoils.

The most effective way of dealing with cottage loaves is to top them immediately the two parts are moulded. They should be allowed to stand for two minutes or so, till the toughness caused by moulding has left the dough, and then bashed, first pressed firmly but not roughly with the heel of the hand, then indented in the

Method of Moulding, &c.

centre with three fingers and the thumb held in the form of a plug. The loaves should then be placed in dusted boxes to prove, and should, if possible, be allowed about twenty minutes after moulding before being set in the oven. Loaves treated in this way do not require any bashing just before setting; it will generally be found quite sufficient to just perforate the centre with the two forefingers or the thumb before placing on the peel or the draw-plate. If only two men are moulding a batch of one sack size, it is not necessary to wait any time after moulding is finished before starting to set, because by the time the last loaf is moulded the first one has acquired considerable proof; indeed, it may easily happen that the first moulded may have enough proof before the whole of the moulding is done, in which case it would be proper to start setting before the moulding is finished.

To prevent Twisting in Oven.

To prevent loaves twisting over in the oven, the greatest care has to be exercised in setting them so that all the loaves are about the same distance apart. When the crown of the oven is very hot, it may be expedient to leave the oven door open for ten minutes till the loaves are sprung nearly enough, and this will help to keep them straight. This advice may seem strange to bakers generally, as the invariable practice is to shut the oven door at once, almost in haste, as soon as the bread is in; yet in the case of an oven too hot on top, it is efficacious for the purpose named, although it necessarily results in the loss of more heat than if the oven door were shut at once. When customers are not averse to having cottage loaves a little crumby on the sides, they may be allowed to touch one way when set, generally at the sides rather than at front and back. This expedient produces the double advantage of retaining moisture better, and therefore increasing the yield of bread, and also of keeping the loaves straight.

Effects of Low and High Crown in Oven.

It is easier to keep cottages quite straight in a low than in a high crown oven, and almost impossible to keep them shapely in an oven with crown so high as in the Scotch type. The explanation seems to be that, as radiant heat proceeds in straight lines only from its source, the loaves in the low-crown oven receive rays only on the top of the top crust, and the exposed top of the bottom crust, the sides of the top crust remaining soft and yielding for some little time, allowing gradual and even expansion upward, as the interior of the loaf expands by heat from the bottom and the top. But in an oven with a high crown, which is arched, the heat rays, coming still in straight lines, but at different angles, bake or crust the sides of the top part of cottages as quickly as they crust the extreme top, with the result that no part yields, and the top of the loaf is lifted all in one piece and perhaps nearly separated from the bottom. The type of cottage loaf called *small top* (Plate ENGLISH CRUSTY BREAD, fig. 5) is not intended to be so light as the other, and is generally set in a rather colder oven without any appreciable proof.

The loaf called a *brick* in London (Plate ENGLISH CRUSTY BREAD, fig. 2) is something like an elongated cottage. Like the latter it is made in two

parts, the top one very much smaller than the bottom. Instead of being moulded round, those parts are rolled up as firmly as possible, finished with the closings upwards. Both closings are then turned downwards, and the parts well pressed together, especially in the centre, with the hand. The details of handling and proving are in all respects similar to those suggested for cottages. When placing on peel for setting, two fingers are pressed in the top of the loaf. These loaves are set in the oven, end to end, touching at the ends if desired, and this arrangement serves, as in the case of cottages, to keep them straight. Those that are batched at the sides are distinguished as *sister bricks*. But this type of loaf is not the only one called brick. In some cases—in parts of Ireland, for instance—loaves are made nearly of this shape, but packed close in the oven; this sort is variously called a *brick*, or a *crumbie brick*, according to the locality where it is made.

London Brick Loaf.

The loaf known generally as *Coburg* (Plate English Crusty Bread, fig. 4) in London, is called a *cake loaf* in Somerset, and a *skull* in the south of Ireland. There is no rule in such matters, so that names have only local, and sometimes very restricted meaning. This sort of loaf, when nicely made, is very showy, and yet requires very little labour. It is simply rolled up in the same way as when handing up, and then proved either closing downwards on a dusted board, or on a dry cloth with closing upwards. The latter method has the advantage where there are draughts in the bakery; it enables a nice soft moist skin to be retained on the top of the loaves, which gives a bright appearance when baked. In spite of the ease with which Coburgs are made, they not infrequently have a dull, poor, pinched appearance, because of the neglect of a few simple details. They are very often not cut nearly deep enough, with the result that the cut hardly shows. They should be cut deeply, with a very sharp knife (a shoemaker's knife is an excellent tool for this purpose and should be kept exclusively for it). Their pinched appearance is generally due to their being set too close together in the oven; they keep each other from spreading out, and so must spring upwards. This loaf should not be cut till it is about to be set in the oven, and should not be allowed full proof before cutting, or it will flatten out instead of spreading and springing, and showing a nice bright surface.

Coburg Loaf.

Manner of Proving.

Not baked close together.

The loaf called sometimes *collar*, *collas*, and sometimes *plait* (Plate English Crusty Bread, fig. 3), is also very showy when nicely made. After a piece large enough has been broken off from the whole piece constituting the loaf, the remainder should be balled up firmly and allowed to stand, preferably upside down, while the plait is being made; the latter should always be made a little shorter than the loaf is intended to be. When the plait is finished, the other piece of dough is taken, closings upwards, and the proof well kneaded out of it, then gently but firmly rolled up, keeping the ends sharp and the middle slacker but still firm, the shape being obtained rather by pressing the dough with both

Collas or Collar.

hands from the two ends to the centre of the loaf than by making the centre loose. It should be finished with a straight closing, which should be exactly in the centre. The loaf is then flattened out by pressing on it, and is turned over, and the plait stretched along the centre of the top and fastened by pressing with the thumbs to the two ends. The mistake **No Crease in Centre necessary.** is frequently made of pressing a crease along the centre of the top of the loaf with the side of the hand, forming a sort of gutter in which the plait lies. This is not only unnecessary but harmful. By adopting the other method suggested, the loaf has a much bolder and nicer appearance, and the plait being shorter than the loaf, lies quite close to the latter, owing to its being stretched. During baking the loaf will crack, either at one or at both sides of the plait The ideal loaf should have a crack at both sides. The crack or cracks always appear, because the plait protects the dough in the centre, and prevents it from crusting, so that this part continues expanding after the remainder of the crust is hard; hence the crack.

Tin loaves of the ordinary type (Plate ENGLISH CRUSTY BREAD, fig. 6), that is, each baked in a separate tin, are usually moulded two at a time, **Tin or Pan Loaves.** one in each hand. They should first be handed up in the ordinary way, then rolled up twice. Failure to mould them firmly often results in moulding holes in the centre or near the sides, while a band or close-textured part all round the tin, with an open texture in the centre, is due to the loaves being placed in cold tins, or proved in a situation where the temperature is less than that of the interior of the loaves. Wherever convenient, tin loaves are always more satisfactory when proved in a prover, although that should not be too hot. What are called **Scotch Tins and Under Tins.** *Scotch tins* are baked in long iron boxes with sliding lids, and are better for sandwich bread than those baked on flat sheets with bread pans placed over them; the latter are usually called *under tins* (Plate ENGLISH TIN BREAD, No. 5). As a rule, Scotch pan loaves cannot be moulded two at a time. They are, for one thing, too long, and cannot be made firm and shapely enough to break with a straight smooth face unless moulded singly. The operation of moulding these loaves cannot easily be described, but consists essentially in pounding all the gas already generated in the dough well out of it, and preventing all chance of large vesicles in the dough, then in forming this toughened and solidified mass into an oblong shape with quite straight ends. These are generally baked four in a pan, and to ensure that they separate with a smooth face each loaf is greased on the ends before being placed in the tin. These require to be proved until they come up to about 1½ in. from the lid; then when baking they will touch the lid and be therefore flat on all four sides. In connection with this type of loaf two things particularly have to be guarded against. The dough must not be allowed to **Effects of Over-proving.** become too ripe before moulding, or the subsequent proving will be very sluggish and the loaves will be quite crumbly, if not sour. Even if the dough is taken "young" or only ripe enough for

TYPES OF ENGLISH TIN BREAD

1. Cut Tin.
2. Split Tin.
3. Oval Tin.
4. Cut Oval Tin.
5. Under Tin.
6. Long Plain Tin.
7. Long Cut Tin.
8. Split Long Tin.

TYPES OF ENGLISH TIN BREAD

this purpose, they must not be allowed excessive proof; otherwise they run into each other and are most unsightly, one loaf having a great cavity in one end into which a protuberance from the next loaf fits.

Split Coburg or French Loaf.

There are several other forms of crusty bread made in addition to those described. One of the best is known generally as a *split Coburg* (Plate SCOTCH AND IRISH LOAVES). This shape is made in small quantities in several parts of the country, but in Victoria, Australia, it constitutes the standard loaf. It is moulded in the same way as an ordinary Coburg, and after it has lost a little of its toughness, a deep crease is made and widened out with a rolling pin. The two halves thus formed but not separated are placed together, and the loaf turned over and proved upside down on a cloth, the latter being folded in such a way as to form partitions of cloth between the individual loaves. When set in the oven the crease opens out, and the loaves look rather nice. If the dough is "green" or "young" when moulded, it may be necessary to grease the crease of the loaf slightly when the crease is newly made; otherwise it may be closed and refuse to open in the oven. If the dough is quite ready, there is no need to use any grease. Like cut Coburgs, these loaves require space in the oven to open out. They may be set quite close at the ends without hurt, but must have space between rows to allow the crease to open.

Home-made Crusty Bread.

Crusty bread of the home-made or farmhouse type is generally made round, sometimes docked on top with a biscuit docker. The same class of bread is at times made long without any marks on the top whatever. These loaves crack on the side as they expand in the oven. In Somersetshire this shape of loaf is called a *brick*, whilst one with an open cut along the centre is a *cut brick*. The same shape, but with a number of cuts diagonally across the top, egg-glazed and well proved, is called a *German long loaf*. In Yorkshire, bread is made in round flat loaves proved very light and called *bread cakes*.

Crumby Loaves.

Crumby loaves made from straight doughs are quite as satisfactory in appearance as those made from sponge and dough; but if the straight dough is a short-process one, then, to get a soft pile on the bread, it is generally necessary to use at least 4 lb. of salt per sack of flour; and to make the loaves separate easily in the oven, it is better to follow the Scotch practice and grease all the sides of loaves after they are moulded when placed in boxes. The great difference between crusty and crumby loaves is that while the former spring in the oven very quickly, and are soon crusted over, and stop growing, the latter spring slowly, and the yeast continues working in them for a considerable time in the oven. On this account loaves intended to be crumby should be set with much less proof than crusty ones, and, as a rule, the dough should be softer. For crumby bread a system of four and a half hours from dough-making to setting in the oven gives excellent results. Scotch and Irish loaves (see the Plate) are quite satisfactory by this method.

CHAPTER XX

METHODS OF BREAD-MAKING: SPONGE AND DOUGH SYSTEM WITH PRESSED YEAST

It is noticeable on all occasions when revolution in processes takes place in connection with any business, that there are always some who cling to the old, not infrequently retaining the parts that are non-essential and changing those that are essential. The sponge system of bread-making was more or less of a necessity when slow-working brewers' yeast or home-made barm was in use, but with the advent of quick-working pressed distillers' yeast the necessity disappeared; yet many bakers still consider that it is impossible to make bulky sweet bread by any other method than the old-fashioned. The use of a sponge is to create a sort of seed bed for the growth of yeast, or to make a very small quantity of yeast perform a large amount of work. By means of a sponge, and with plenty of time, it is possible to ferment a sack of flour as effectively with 4 oz. of yeast as if 4 lb. had been used: not that the smaller amount can by any means be made to do the work of the larger, but that the former, if sown in a proper medium and allowed sufficient time, really becomes the larger quantity, and does the work accordingly.

Advent of Pressed Yeast.

Use of Sponge in Bread-making.

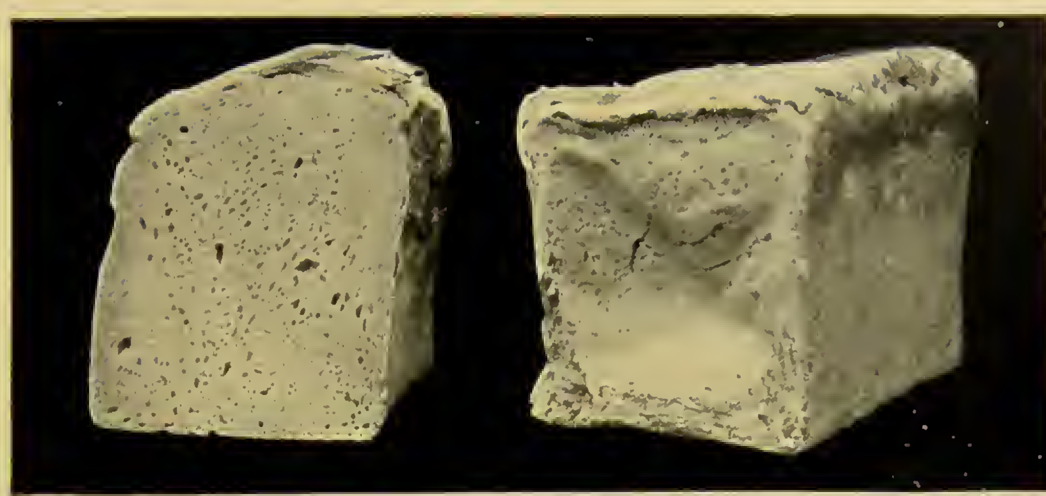
The principles involved in the use of a sponge are identical with those that apply when leaven is in use. It is not only that the sponge, when made into dough with more water and flour, contains many times the quantity of yeast that was originally mixed with it, but the material of the sponge—the flour—has also changed its character, and its gluten has a softening effect on the gluten of the flour used in making dough. In addition, there are certain products of the fermentation of the flour of the sponge, notably the acid matters, which also accelerate the ripening of the subsequent dough. It is not, therefore, a mere growth of yeast which accounts for the behaviour of dough made from a sponge, or that accounts for the character of the bread so made. Making all allowances for prejudice, it is certain that there is a marked difference between bread made on the straight-dough system and that made from sponge, when both have occupied the same time, although this difference is less marked when both systems have been long ones. It is not wholly prejudice which ascribes greater bulk and softness to bread made on the sponge system. These qualities are really pronounced enough to leave no doubt. But even if this is granted, the sponge system has so many drawbacks and the straight-dough system so many advantages, that the latter is to be preferred, especially as there is no real barrier by its use

Sponge and Leaven compared.

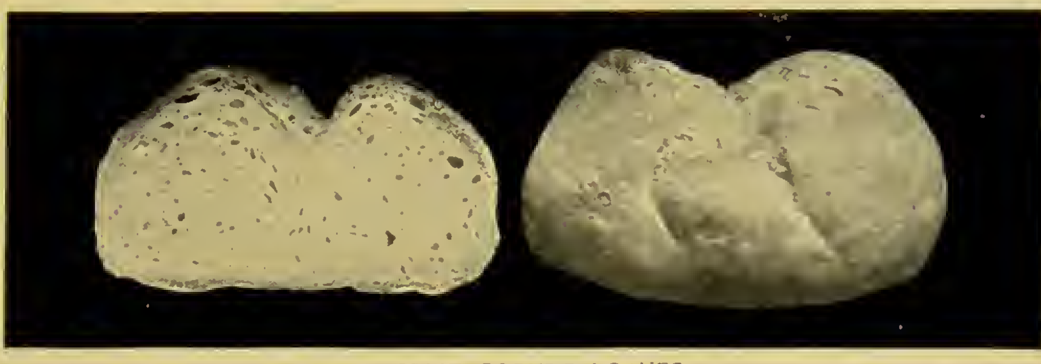
Ripening Effects of Sponge.

Difference in Bread from Sponge and Straight Dough.

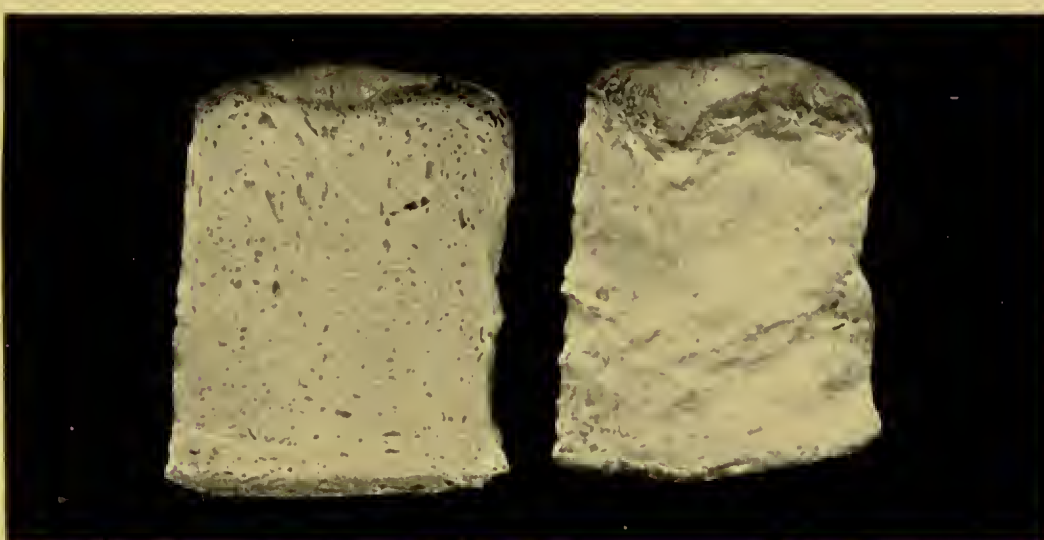
Preference for Straight Doughs.



1. SCOTCH CLOSE-PAN LOAVES



2. SPLIT COBURG LOAVES



3. IRISH BATCH BREAD

4. SCOTCH SQUARE LOAVES

(12)

TYPES OF SCOTCH AND IRISH LOAVES

to making bread quite bulky and soft enough for all ordinary requirements. It is, however, in some cases a matter of convenience to have a sponge or dough standing overnight, and then, all things considered, the long-sponge gives safer if not better results than the long-dough system. If a sponge has to lie a long time—and a twelve-hours limit is about the maximum—it should be larger in proportion to the total quantity of flour used, and should be made stiffer than one to lie a much shorter time; otherwise there is a danger of its becoming quite degraded, so far as its gluten is concerned, and its yeast food exhausted, with the consequent weakening of the yeast.

Long Sponges.

For a sponge to stand twelve hours the following ingredients may be used for a batch consisting of one sack flour: flour, 120 lb.; distillers' yeast, 6 oz.; salt, 6 oz.; water, 65 lb., or $6\frac{1}{2}$ gal., at a temperature sufficient to make sponge of 76° F. This sponge, virtually a soft dough, should be well made and toughened by kneading. In the time specified it will have risen in the tub or trough and dropped once, and will have come up a second time, and should then be ready for making into dough.

Quantities for Twelve-Hours Sponge.

As this is the first mention of sponge "dropping", it may serve a good purpose to explain its significance, and to dispel the notion generally held by bakers that it is, in all circumstances, a true and infallible sign that the sponge is ready. A sponge drops because the tension of the gluten of the flour of which it is composed is no longer able to sustain the pressure of the expanding gas within. This breaking of the gluten depends on quite a number of things. It depends on the amount of gas produced by the yeast, which, in turn, is a rough measure of the yeast's energy and of the quantity of new yeast formed, and to this extent it is also a measure of the readiness of the yeast for its subsequent work in dough. But dropping of sponge is also determined by the toughness and stability of the flour used, as well as by the stiffness of the sponge or the proportion of flour to water in it, for it is evident that a sponge made of soft flour will not so long retain the gas produced as will a strong, tough flour, nor will a slack sponge stand so long before dropping as one that is comparatively stiff. The significance of all this is that dropping is only a safe sign of readiness as between sponges containing the same kind and quantity of flour, and fermented under identical conditions; hence the necessity for the greatest care in keeping to correct quantities at all times. If a standard sponge is made with strong flour, and it is ripe only when it has dropped, then if the same sponge were made with soft flour, it might drop and yet be not nearly ready, because a smaller quantity of gas was sufficient to break it, and in the time taken only a smaller quantity of new yeast had been formed. On the other hand, if the standard sponge were of soft flour, one with strong flour might be actually riper before it dropped than the standard one after it had dropped, and the former, in con-

Sponge Dropping.

Signs of Readiness.

Danger of Relying on the Drop only.

sequence of the greater increase of yeast which had been formed, would produce the more active fermentation at the dough stage.

When the sponge, for which quantities have been given, is to be made into dough, it will require, besides the 160 lb. of flour remaining of the sack, about 7½ gal. of water if for crusty cottage bread, 8 gal. if for flat shapes, and 8½ gal. if for tins. In addition, 3 lb. 2 oz. of salt should be used, and 1 lb. of sugar, or glucose. The small quantity of salt added to the sponge has been in no way altered by fermentation, although it serves to steady the process, so that the total salt per sack of flour is 3½ lb. If the whole flour were made into straight dough, to stand so long it would be advisable to use ½ lb. or even 1 lb. more salt. The temperature of the water should be such as to make dough about 82° F. when finished. Sugar, or other gas-producing yeast food here suggested, is for the purpose of increasing the speed of yeast action at the time when most effective in producing bulky bread, viz., after the loaves are moulded and when newly set in the oven. If the dough is to be made by hand, the most important operation is breaking sponge. This consists in breaking the sponge so thoroughly amongst the water that the whole becomes a milky fluid in which no particles of sponge are left. Failure to do this properly often results in very irregular and holey bread. If the dough is machine-made, breaking sponge amongst the water is not a necessary preliminary operation. The machine is quite capable of thoroughly mixing flour, sponge, and water, when all are added together, and even better in that way than if sponge and water are first mixed, for, when the former becomes broken into small pieces, these slide round the arms of the machine and refuse to be broken further or to mix; but this is prevented when all the ingredients are mixed at once. When the dough is well made, it will require to lie in the trough for about one hour, and be then cut back and well kneaded. It must then be allowed from half to three-quarters of an hour more before being kneaded again, and thrown out to be scaled. The remainder of the operation need not differ in any way from that already described for straight doughs.

Making Dough with Sponge.

Purpose of Sugar in Dough.

Breaking Sponge.

Sponge-breaking not needed with Machines.

For a ten-hours sponge use 120 lb. flour, 9 oz. yeast, 6 oz. salt, 65 lb. or 6½ gal. water at a temperature sufficient to make sponge 76° when finished. This sponge will be dropped about 4 or 5 in. at the end of ten hours. Make dough then with 160 lb. flour, 3 lb. 4 oz. salt, 1 lb. sugar, and 7½ gal. water if for crusty bread, but ½ gal. more if for crumby or tins. This dough would be ready for scaling in one to one and a half hours after making.

Ten-Hours Sponge

Sponges of this length are not common except in Scotland and Ireland, and they are used principally because of the interval they allow between the end of one day's work and the beginning of the next. In England, and particularly in London, a sponge standing from six to eight hours is more favoured, but this entails

Reason for Long Sponges in Scotland and Ireland.

the attendance in the bakery of one or more men at some time about mid-way between successive days' work, thus making the work, or at least the mental strain of it, never-ending for someone.

Eight-Hours Sponge.

For an eight-hours sponge the ingredients might be the same as above, except that 12 to 14 oz. of yeast would be required. The sponge would be broken up in the morning in the usual way, adding as before, for a one-sack batch, 3½ lb. of salt and 1 lb. sugar or glucose. The dough in this case would be ready for sealing in two hours from the time of making, having been cut back and kneaded once in that time.

Soft Sponge.

Instead of making sponge so tight as this, good results are obtained by making a much larger and softer sponge. For eight hours use the following: 6 gal. water, 10 oz. yeast, ½ lb. salt, and 100 lb. flour—the strongest in the mixture should be used at this stage. This sponge will be much more easily broken up when it comes to the dough stage. For dough the remainder of the sack of flour, 180 lb., is used; with 1 lb. sugar, glucose, or malt flour; 3 lb. salt; and 8 to 8½ gal. water. When the dough is well made it is allowed to lie from one to one and a half hour, is then cut back and kneaded and given another half-hour in the trough, when it is ready for sealing.

Short-Sponge Methods.

Still shorter sponge methods are now used by those who believe in sponges. Of these methods the following may be given as an example from which excellent results are produced. A thin sponge or ferment is made with 25 lb. flour and 2½ gal. water at 100° F., 1 lb. yeast, and ½ lb. sugar; no salt. This stands for about one and a half hour, and is then made into dough with 255 lb. flour (constituting altogether one sack), 12 gal. water at a temperature sufficient to make dough 80° F. when finished, and 3½ lb. salt. This dough stands one hour, and is then cut back and well kneaded. In from forty to forty-five minutes more it is ready for scaling and working up in the usual way. The quantity of yeast used here is a little less than would be necessary if dough had been made straight away, the soft sponge or ferment at the first stage increasing yeast growth to a greater extent than if yeast were working only in straight, stiff dough. When a sponge is to lie only such a short time as here given, it should never be made stiff, and yet is better when thick enough to be past the watery state, so that the starch of the flour should not fall to the bottom.

Ratio of Yeast in Sponge and Dough.

Yeast Management for Straight Dough.

There is very little difference between this kind of sponge, except in the slight difference of time, and the sort which should always be prepared as a preliminary to making straight dough. Even when dough is to be made right off, the yeast should first be weighed, and then mixed with about 1 gal. water about 90° F., and say 5 lb. flour, and any yeast food it is intended to use. While the flour is being sifted, the salt weighed, and the water prepared, the yeast is not only increasing in quantity, but is preparing its own food and becoming what may be called acclimatized to its new condition in a flour medium; and accordingly, when the dough is mixed, the fermentation starts vigorously at once.

Scotch and Irish Methods of Bread-making.

A sponge system for long periods has already been given, and this may be used for Scotch or Irish bread with good results. But, as already mentioned, as much as 5½ to 6 lb. of salt is needed to secure the necessary pile on the loaves. The Scotch and Irish methods as generally followed vary a good deal from that given. On the east coast of Scotland generally, the system followed is that of half-sponge, the half, or nearly the half, of the total water required to make dough being used at that stage. There is, however, great latitude exercised by individual bakers as to the amount of liquor used in sponge, as well as in the stiffness the half-sponge is made. In some cases it is made soft and tough, in others as stiff as an ordinary dough. Within limits the soft sponge produces the clearer loaf and gives much less trouble, particularly if the dough is to be hand-made. If the dough is machine-made the point is not of so much importance.

Half-Sponge to stand Thirteen Hours.

For a half-sponge to stand thirteen hours the following may be used. 6 gal. of water at 90° F. has 1 lb. salt dissolved in it, and then 5 oz. compressed yeast is thoroughly mixed. In the trough there is about 100 lb. flour. Into a bay made with this flour the liquor as above is poured, and the whole smartly made into a soft dough, which is worked and flapped over and over so as to make it as tough as possible, and also well pinched till it becomes quite clear and smooth without being sticky. It can then, with slight dusting, be easily handled, and is thoroughly well kneaded, which has the effect of increasing its toughness. It is then lifted in pieces and dropped into a deep tub, which has been thoroughly scalded, and well dusted with cones inside, so that the sponge may more easily slip out of the tub into the trough or machine in the morning. This sponge will rise and fall once and come up a second time.

Dough-making and Manipulation.

In the morning, if the dough is hand-made, the sponge is broken up in the remaining water required for dough, about 9 gal., which should be at a temperature that will make dough about 78° F., and with it is mixed from 3½ to 4 lb. salt and ½ lb. sugar or other yeast food. If the dough is made in a machine, the flour, the sponge, and the water may all be tipped in together, the water, of course, having salt, &c., already dissolved in it before mixing starts, and the whole thoroughly incorporated. As already noticed, long experience has proved that this method is quicker and more effective for proper mixing than any method of first breaking up the sponge in liquor alone. When the dough is well made and clear, it is pinned up in the trough and allowed to stand about one and a half hour. It is then cut back and well kneaded, and given about three-quarters more in the trough, when it should be ready for scaling. The loaves are handed up into boxes dusted with cones, and are allowed about fifteen or twenty minutes' proof at that stage, when they are ready for moulding. When moulded they are again packed tightly into boxes, all the sides and ends being greased with melted lard, with the exception of the contiguous sides of loaves intended to adhere to each other. They are then docked on top, and washed over

either with milk or with water. In this state they are allowed to lie some fifteen or twenty minutes more to prove, and are then run or set in the oven in pairs, except, of course, where draw-plate ovens are in use, when they are set two rows or courses at once, from long boards, the width of the oven, on which they are placed when newly moulded. The loaves are set quite close together on all sides and spring to a height of about 6 in. As heat can only get directly at them on top and bottom, a batch may occupy from one and a half to two and a quarter hours to bake, according to the heat of the oven.

Setting in Peel and Draw-plate Ovens.

Bakers in Scotland have not yet adopted compressed yeast to any great extent for their plain bread, but a good many are now using it for pan bread and fancy sorts, and its progress towards universal use is becoming more rapid. When Parisian Barm (see Chapter XXIV, p. 142) is used, the procedure does not materially differ from that just described, the quantity of barm necessary being about 1½ Scotch pint, or, roughly, ¾ gal. If compound or patent barm (see Chapter XXIII, p. 138) is used, the quantity necessary, if the barm is strong, would be about 1¼ Scotch pint, or about 5 pints imperial.

Scotch Bakers and Compressed Yeast.

Sponges with Parisian or Compound Barm.

In the West of Scotland the usual custom is to make bread in three stages, viz., quarter-sponge, batter sponge, and dough. The first of these is comparatively small, consisting roughly of about one-quarter of the total liquor required for dough, but generally less. This would be for a sack batch, say, 3 gal. water. The temperature varies with the season of the year, but should always be high enough to make the sponge, when finished, from 74° to 78° F., the former for summer, the latter for winter months; for in the cold season, although the temperature outside may be very low, that, as a rule, in the bakehouse is purposely kept high, and the sponges at that period are also given extra protection with sacks. Quarter-sponges are always kept in tubs, although the practice differs as to whether they are actually made in tubs or on the table. If the former method is followed, the sponge is first well stirred with one hand until it becomes too thick to stir longer; both hands are then used, and the sponge is pinched from the sides of the tub to the centre, and flapped over repeatedly until it becomes very tough. It is then emptied from the tub on to the table or trough, the tub is scraped clean and well dusted, and the sponge is further kneaded and folded to toughen it more, after which it is returned to the dry-dusted tub, which is well covered and, in winter, placed in a warm situation in the bakehouse, where it will not be disturbed, or, if in the heat of summer, placed in as cool a situation as possible, even at times in the open air, with only sufficient covering to prevent its becoming skinned. This kind of sponge is always made soft. For the quantity of liquor given above, 3 gal., not more than 45 lb. of flour would be used, and 2 quarts or 5 lb. barm.

West of Scotland Methods.

Making Quarter-Sponge.

This would generally be strong flour, but no great stress is laid on that point, although really soft flour is never used. About 8 oz. of salt is used at this stage. The time the sponge is allowed to lie is not fixed by any universal standard, but each bakehouse has rules of its own in this matter. In some cases it may stand sixteen hours before being again touched, but thirteen to fourteen hours is the usual period. In a case within the writer's knowledge, when the master baker had scruples about Sunday labour, even for work of this kind, the quarter-sponge was made about nine o'clock on Saturday night and not touched again until five o'clock on Monday morning, thus standing about thirty-two hours. The resultant bread, while no improvement on that made by the usual method, showed no serious defects except smallness. In abnormal circumstances like this ordinary ripe barm was not used, but some that was new and immature, and therefore contained a smaller quantity of yeast cells than usual, so that some part of the long period during which the sponge was working was really occupied in producing yeast cells to do the subsequent work of fermenting the dough, which in ordinary circumstances would have been included in the quantity used at the beginning.

Quantities for Quarter-Sponge.

Time Sponge lies.

Excessive Length of Sponge Period.

The second operation, however long the sponge has stood, is to make it into a batter sponge with more water and flour. It is ready for this stage if it has risen twice and dropped 3 or 4 in. in the quarter tub. The batter sponge is always made in a tub of large capacity, because it is thin and expands a great deal. In factories the stirring of this sponge is done by a machine (fig. 10), which consists of a long spindle with arms nearly the length of the radius of the tub. This spindle is part of the machine, which is generally fixed to the wall of the bakehouse, but it is made to slide down into the tub, which is placed underneath, and the end of the spindle fits into a socket fixed in the bottom of the tub. In small bakeries the stirring has to be done by hand, or rather by the arm. For a sack batch this sponge requires about 11 gal. of water, or, virtually, all the remainder after that already in the quarter, except about ¾ gal. to be used to rinse down the inside of the large tub after the sponge is emptied into the trough, the rinsings constituting part of the liquor used for dough-making. The quantity of flour used is roughly 110 lb., and of salt at this stage 2 lb. Water for this sponge is comparatively hot in winter-time. It may even be too hot for it to be safe to empty sponge in, and the expedient has then to be adopted of stirring a quantity of cold flour into the water after the salt, but before adding the quarter. As a rule the temperature of this batter sponge when finished is from 82° to 84° F. Quarter-sponge and water have first to be broken up very thoroughly, until the whole becomes a milky fluid, the quarter having really dissolved, so far as its gluten is concerned, in the water. This state of solubility is the effect of the cumulative action of yeast, and of the acids produced

Batter Sponge.

How to Deal with Sponge in very Cold Weather.

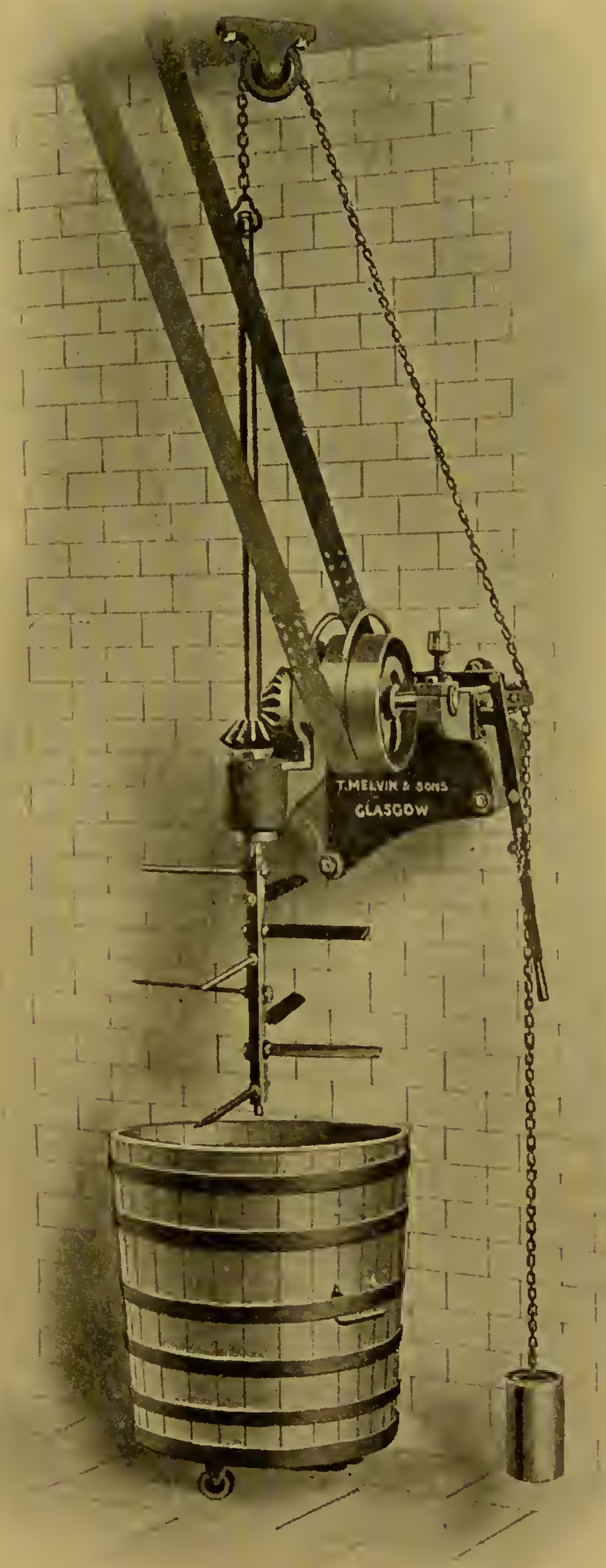


Fig. 10.—Sponge-stirring Machine

during fermentation of the quarter. If, instead of dissolving, the quarter is very tough, and breaks up only into stringy pieces, then it has not been enough fermented, or as usually expressed, "wrought" or "ripened" sufficiently. Should this be the case, the second sponge should, if possible, be made a little warmer; but a better plan is to add a quantity of pressed yeast, or, failing that, of barm at this stage, to make up for the deficient quantity which has been produced in the quarter. When the stirring is finished, the top part of the tub is neatly scraped down to the edge of the body of the sponge, so that any drop of the latter may be noticed. Almost as soon as stirring is finished, bubbles of gas begin to appear on the surface, and fermentation proceeds very rapidly. In from one to one and a half hour this sponge will be ready, the general sign being that it has "turned", as shown by a crease in the centre. It is then emptied into the trough, which has the remaining flour banked up at each end, the salt (3 lb.) being weighed and placed in the centre of the "bay" thus formed. The tub is well scraped down, and rinsed out with about $\frac{3}{4}$ gal. of the water reserved for that purpose, the temperature of this water being regulated according to the readiness or otherwise of the sponge—colder if too ready, hotter if not quite ready. The rinsings are also poured into the trough if the dough is hand-made, and the whole is mixed together, care being taken that the salt is thoroughly dissolved. When the dough is well made and clear, it is "pinned" up and allowed to lie from one to one and a half hour, then cut back and kneaded. It is then left in the trough for about three-quarters of an hour more, after which it is weighed, handed up, moulded, and set in the oven in the usual way, with intervals of about twenty minutes between handing up and moulding or "chaffing", and between moulding and "setting", or, to use the Scotch word, "running" in oven.

Condition of Quarter when ready.

Quick Fermentation of Sponge.

This method of bread-making can be adopted with compressed yeast, the details being followed in every particular, except that the quantity of pressed distillers' yeast necessary in the sponge would not be more than 5 oz. Whatever kind of yeast is used, however, this method is not suitable for crusty loaves of the English cottage type. These, if made from dough of this kind, unless it is very stiff, soften in the oven and flatten out, a tough skin being produced.

Method with Compressed Yeast.

CHAPTER XXI

METHODS OF BREAD-MAKING: FERMENT, SPONGE, AND DOUGH

The English equivalent of the Scotch method of quartering is the method of ferment, sponge, and dough. This system is now nearly discontinued. Brewers' thick yeast or patent barm is generally used, but compressed distillers' may be used if con-

Ferment, Sponge, and Dough.

venient. With brewers' yeast the quantities and method for a one-sack batch are as follows. From 8 to 12 lb. of potatoes are steamed, generally in an ordinary iron pot in the oven, about 2 quarts of water being sufficient to do this in 1½ hour. These potatoes, when done, are well mashed and 3 lb. flour added, about 1 gal. more hot water about 180° F. is poured on, and the whole thoroughly stirred. Another gallon of cold water is then added to reduce the temperature to about 80° F., 3 lb. more raw flour is then stirred in, care being taken to prevent lumps. This is then stocked with 2½ pints brewers' yeast, and covered up with a sack in the tub. In about 5 hours it will have risen and dropped twice, and will be ready for making into sponge. This is invariably made in one end of the trough in which the whole of the flour for the batch is already "pitched". For sponge, 6 gal. of water at a temperature sufficient to make dough about 78° is used, and 1 lb. salt. This ferment is made quite soft and tough. In 6 hours it will be dropped and ready for making into dough. For that purpose 6 to 7 gal. of water at a temperature to make dough 78° F. is used, according to whether dough is wanted for crusty or crumby loaves; 2½ to 3 lb. salt is added at this stage, but it is not usual to add sugar or other yeast food when this method is followed. The dough is ready for scaling in about 2 hours, but half an hour at least before throwing out it should be cut back and well kneaded. The loaves, after sealing, are dealt with in the usual way.

Brewers' Yeast and Potatoes.

Making Sponge with Ferment.

This process of bread-making is old-fashioned, and was suitable for the time when slow-working liquid yeasts or barms were in use, as the ferment is really a medium for the growth of new yeast, and the baker is really his own yeast-manufacturer. Excellent bread can be made in this way, if care is exercised, but in the ordinary course when the method was common it not infrequently produced sourness, while holes and irregular texture were constant troubles. The former of these defects arose principally from the careless way in which ferments were treated. Although from 5 to 6 hours was the nominal time for ferment to stand, it was quite a common thing to leave it for hours afterwards before making up into sponge, with the result that souring ferments were allowed to grow to an excessive degree. Potatoes mashed in their skins, as was the invariable practice, are productive of sourness very quickly. Holes are usually caused in bread made on this system by the sponge not being properly broken when the dough is made.

Purpose of Ferment and Sponge.

Careless Practices of the Bakery.

There are still many bakers who believe in the use of potatoes, in spite of their dirt and trouble, but the method followed is in two instead of three stages—either sponge and dough or ferment and dough. Distillers' pressed yeast is now generally used. The following is the process adopted in a leading West-End London bakery. 16 lbs. of sound potatoes are well washed and cooked in an iron pot, with a close lid, in the oven. Only 2 quarts of water is used, and the potatoes are

Potatoes still Used.

sufficiently cooked in 1½ hour. They are then mashed along with 4 lb. of flour, and 3 gal. of nearly boiling water added, and the whole is well stirred. With this 17 gal. more water is used, at a temperature to make the whole 84° F. With this is dissolved 4 lb. of yeast, and the tub containing the whole liquor covered with a sack. In 1½ hour it will turn and will then be ready to use. This is sufficient for two sacks of flour. At dough-making 7 to 8 gal. more water is used, with 6 lb. salt. The dough when made should be about 80° F. when the bakery is at, say 66° F.; the temperature of dough is made less should the bakery be warmer. When the dough has been made 1 hour, it is cut back and kneaded, and afterwards allowed 1½ hour in the trough before scaling. The mode of manipulation is then identical with that followed on other systems. Bread made thus is usually sweet, not over-bulky, and has a rich bloom. The greatest danger with such a large quantity of yeast is that the loaves may become dry and crumbly, if anything occurs to keep the dough a little longer on the way than usual.

Old-fashioned West-End Method.

A supreme faith in potatoes as a bread-improver induces some bakers to use them even in short-system straight doughs, the idea being that they keep bread moist, but in this respect they are no more effective than ordinary flour or starch scalded. Moistness in bread made with potatoes, on a system consisting of two or three stages, probably owes more to the system and the condition of the gluten of the flour which it produces than to anything special in the constituents of the potatoes.

Faith in Potatoes.

CHAPTER XXII

METHODS OF BREAD-MAKING: WHOLEMEAL, BRAN, AND BROWN BREADS

There is a sentimental as well as a dietetic value attached to the use of wholemeal bread. The writer remembers an old lady customer who, in ordering brown bread, insisted that it should be from meal just as God made it. This request was made without the least suspicion of irreverence, and it really indicates the spirit which actuates a great many people who are users of and advocates for wholemeal bread. They imagine that as the wheat grows naturally so it was intended for the food of man, and that to take any of the parts away is really an act in the nature of a sin. The baker need have no quarrel with the reasons which induce his customers to prefer one kind of bread to another. So long as the trade is profitable, his business is to supply exactly what is required. There may be, in the parts of wheat eliminated from the wholemeal, a greater proportion of mineral matter in the form of phosphates than in white flour itself, but the nature of bran renders those useless as food to human beings, and in

Natural Meal.

Superiority of White Flour as Food.

consequence of the large proportion of comparatively insoluble cellulose which the branny part of wholemeal contains, the proportion of proteid matter (gluten, &c.), which is the flesh-forming constituent of wheat, is really greater, weight for weight, in white flour than in wholemeal.

At one time, the practice was very common with bakers of mixing a few handfuls of bran with white flour, and calling the bread made from it wholemeal. This practice is now quite discontinued, unless bran bread is specially asked for, and genuine wholemeal is used. For a long time the favourite meal was coarsely ground, in some cases more like broken wheat than meal, but this is not now much in use, although for securing a pleasant wheaty flavour in bread, or for promoting digestion in cases where the organs are sluggish, this coarse meal, if properly made into bread, is to be preferred to that ground very fine. Several patents have been taken out for making wheat into bread without any preliminary grinding whatever. The principal expedient in some of these processes was to soak the wheat for a time in water until it became quite soft, when it was forced through fine apertures until it formed a kind of thick paste or mush, which was then made into dough and partly fermented with yeast. The sticky, pasty nature of the softened wheat made the bread so produced very close and heavy, although not without a pleasant flavour. Much advertising of the high dietetic value of this kind of bread failed, however, to retain the favour of the public, who really like their bread, whether brown or white, to be light and easy to chew.

Use of Coarse Meal.

Softened Wheat Bread.

What is known as *Graham bread* (see Plate VIENNA FANCY BREAD—V, Nos. 2, 8), after an American doctor of that name, is made somewhat in this way, although the reference above is not to that, but to a more recent German process. Graham bread is made by soaking bruised wheat in lukewarm water sufficient to make it into soft dough. This dough is divided at once into pieces the size required for loaves, generally 1 lb., and these, when moulded, are allowed to rest for 3 or 4 hours; they are then baked in an oven about 400° F., and will require from 1 to $1\frac{1}{2}$ hour. No yeast is used, yet the loaves spring a little, owing to the expansion of the water and steam which has been imprisoned in the soaked grain.

Graham Bread.

A sect called the Wallaceites, who believe that yeast is the cause of several diseases, on that account use no yeast in their bread, which is also made of entire wheatmeal. Their ordinary bread, since they use no other aerating agent, is close and heavy; but in the higher-priced article eggs are used, although the egg bread is not what an ordinary person would call light.

Wallaceite Bread.

The present practice is to make what is called *decorticated meal*, that is, wholemeal from which the outer skins of the bran have been removed. Some millers, to ensure that the customers who object to coarse bran lose nothing by its rejection, replace its weight in the wholemeal which they prepare by adding an equal weight of fine

Decorticated Meal.

offal, sometimes called "middlings" and sometimes "pollard". The meal so prepared is almost like a very coarse brown flour. It can be used by itself for making comparatively light bread, but, as indicated hereafter, the writer prefers to increase slightly the quantity of white flour it contains. Many millers make a speciality of wholemeal, and, when this is the case, there are stones dressed specially in the mill for grinding meal only, and particular wheats, generally of superior quality but soft, are kept for this product. **Special Wheats and Grinding.** This very particular care on the part of millers in preparing meal has had a great deal to do with the much greater favour with which brown breads are now received by the public. At one time bakers were afraid of wholemeal. It was considered almost impossible to make it into bread, without having it either very solid or very sour, especially if yeast was used as the aerating agent. The probable cause of this constant trouble was that millers at one time considered any sort of wheat good enough for wholemeal, and as the product was naturally brown, took no pains in cleaning wheat to be used for this purpose. The modern idea, as just indicated, is to take quite as much care in the selection and preparation of the wheat for wholemeal as for that to be made into the finest white flour.

Wholemeal contains the germ of the wheat, as well as all the other parts that might be classed as offal, but germ itself has constituents so high **Germ in Meal.** in nutrient value, and has, withal, so sweet and pleasant a flavour, that it is now very largely used along with white flour in a number of patent breads, such as Hovis, Daren, Cytos, Wando, &c. For these breads the germ of wheat is very carefully separated and mixed in the proportion of about 75 per cent of white flour with 25 per cent of pure germ, to make the prepared meals. Pure germ, if kept in a cool dry place, remains quite sound and sweet for almost any length of time, at least quite safely for one year, but when mixed with white flour it quickly becomes either musty or rancid to smell and taste, owing to the unstable nature of the oily matter, of which germ contains a higher **Germ Breads.** proportion than any other part of the wheat. In consequence of this instability when mixed, all those germ meals have about 5 lb. of salt per sack also mixed in the meal, as a means of preventing deterioration in the manner described. Those patent germ meals, therefore, have no salt used with them when made into dough. Like wholemeal, these meals absorb a great deal of water, and are usually made soft in dough, with a considerable quantity of yeast, so that the process is quick, one of the objects being to increase the yield of bread, but a **The Public and Brown Breads.** quick process in this case also, as in that of wholemeal, retains the natural flavour of the meal. The trade in brown breads is not nearly so regular as that in white. It depends a good deal on sentiment, and although the flavour of the several sorts is characteristic in each case, and people like these breads for a time, their fancy is liable to constant change, preferring now one sort and now another.

In addition to what may be called natural brown breads several

varieties are made in which malt meal or malt flour or malt extracts are used to improve the flavour, and, ostensibly, to help digestion. Another class contains meal prepared from wheat that has been itself malted. Rye in some cases forms part of the mixture for brown bread, but its use is confined almost wholly to continental countries. It was at one time in much more common use in this country, and is still to be found in isolated cases.

Proprietary Special Breads.

Plain Brown Bread with Coarse Meal.

Weigh 6 lb. coarse meal and 2 lb. fine flour, and mix well together. Make into straight dough, using 2 oz. salt, 1 oz. sugar, 2 oz. lard, 2 oz. yeast, and 2 quarts and ½ pint water at 102° F. The lard should be rubbed into the meal in the usual way, whilst the salt and the sugar are dissolved in the water, and the yeast is also thoroughly mixed in the water. There is no danger of injuring the yeast by water at this temperature, as some bakers fear, for the cooling effects of the yeast itself, as well as those of the salt and sugar, are sufficient to reduce the temperature of the water well below the danger point. When the dough is made, it should be quite clear and free from scraps, and should be toughened by thorough mixing. It should be kept in a basin covered up, and in a situation where the temperature is constant between 80° and 90° F. In such circumstances the dough will be ready for scaling and moulding in exactly one hour, but before scaling it should be well kneaded. When moulding, whether to be baked under covers or in open tins, it gives the loaves a nice coarse appearance which satisfies the ideas of those who prefer this kind of bread if it is moulded or rolled in coarse broken wheat or meal. The loaves should stand, covered up again, in a moderately warm place for from 40 to 50 minutes, when they should be ready for the oven. Small sizes, each loaf weighing 1 lb., will bake in 35 minutes in an oven at a temperature of 430° F.; the larger size, weighing 1¾ lb. or 2 lb., will bake in 55 to 60 minutes. As coarse meal is generally "straight run" and contains the whole of the bran, it does not by itself produce bulky bread; hence the addition of 25 per cent of white flour, which assists to that end. There are many customers, however, who prefer their wholemeal bread quite close and small. For such customers the process followed should be exactly as described, only the white flour is replaced by 2 lb. additional meal. This method of working gives a meal loaf that retains the proper wheaty flavour, and if care is taken that it does not become over-proved, it will be neither holey nor crumbly.

Moulding and Proving.

Fine Meal.

Within the last dozen years or so much finer meal has gradually come into favour. These meals were for some time described as *decorticated*, because of the removal of the coarse bran. The bran is still in great part removed, but this description for the meal is seldom used now. These meals are ground quite fine, almost resembling in appearance very dark coarse flour. With such meal it is not necessary to use any white flour at all, but as there is difficulty in getting the bread quite bulky enough with meal only, 7 lb. of meal and

1 lb. of flour make an excellent mixture. The quantities of materials and the method of procedure may be exactly as already described for coarse meal, and a most satisfactory loaf may be thus produced. With fine meal 3 oz. of malt flour to 8 lb. of meal may be used with advantage. This quantity just makes its presence felt, without making the flavour of malt too pronounced or the bread too sweet; and it also assists in giving the loaves a rich colour and bloom. To remedy the complaint so frequently made regarding brown bread, that it becomes dry and chaffy when stale, the addition of 3 oz. ordinary golden syrup to the dough, in place of the sugar in the mixture given, is helpful.

Addition of Malt Flour.

Long-process Wholemeal Bread.

It is quite a common practice of the bakery to make brown bread overnight. This method will produce quite large-looking loaves, but they are almost wholly devoid of flavour, or, more frequently, have a decided twang of sourness; on this account, if for no other reason, the short system is much to be preferred.

Wholemeal with Sponge.

The old-fashioned method of making brown bread was to prepare a white sponge, into which the meal was doughed when ready. This is not a good plan. Besides causing a larger addition than necessary of white flour, there is the ever-present danger of the comparatively white sponge not being smoothly mixed with the meal, resulting in the bread being patchy or streaky.

Wholemeal with Powder.

Fine meal is sometimes aerated with soda and cream of tartar instead of with yeast. For this purpose 1 oz. of bicarbonate of soda and 2 oz. of cream of tartar should be used for every 5 lb. of meal. If possible, the liquor used—1 quart and ½ pint to 5 lb. meal—should be half milk half water, or, better still, all milk. With this quantity 3 oz. of sugar and 5 oz. of lard effect a great improvement. Some meals may require as much as 3 pints of water or milk. This sort of bread is better made of rather soft dough, as it only needs handling once, and it can be readily moulded in dry meal before being placed in tins.

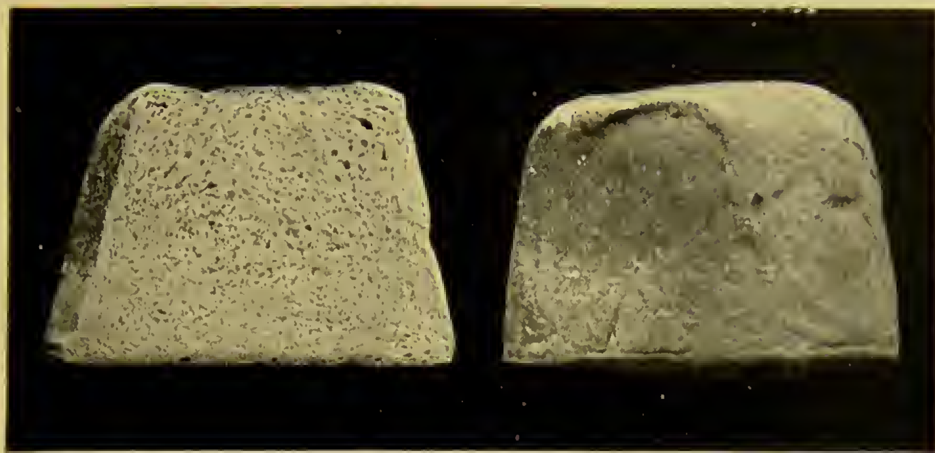
Oaten Wheatmeal Bread.

A nutritious and very palatable brown bread is made by using a mixture of half fine oatmeal and half wholemeal, with which is thoroughly mixed 1 oz. of soda and 1½ oz. of cream of tartar for every 5 lb. of the mixed meal used. About 4 oz. of lard is rubbed into the meal, and a rather soft dough made with 1 quart and 1 pint milk and 4 oz. golden syrup. This kind of bread should be baked in a cool oven, say about 400° F.

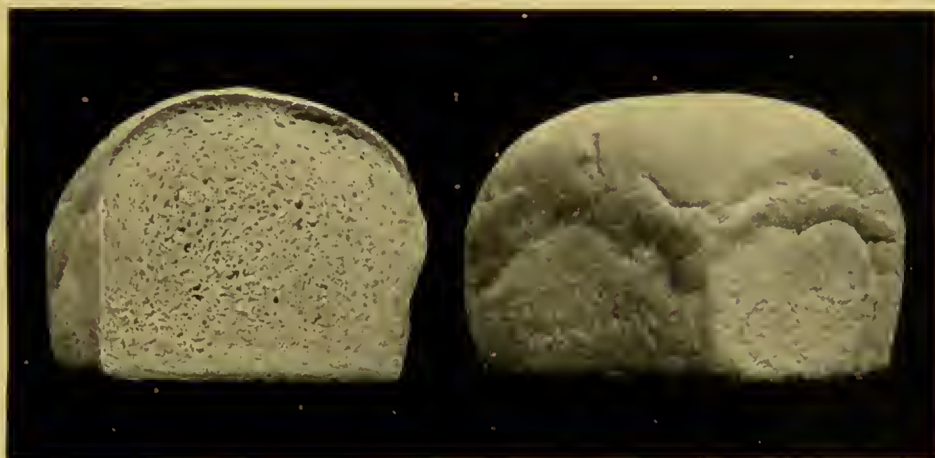
Malted Brown Bread.

Of the methods of using malt in malted brown bread the simplest is to add 2 oz. of malt flour for each pound of meal used, and then ferment it in the way already described for plain wholemeal, using, of course, the same proportions of white flour and other ingredients as there given. This produces a moderately good result in the matter of malt flavour and bloom, but does not retain its moistness in the same way as malted bread prepared by other methods.

The following method of preparing malt bread was introduced about

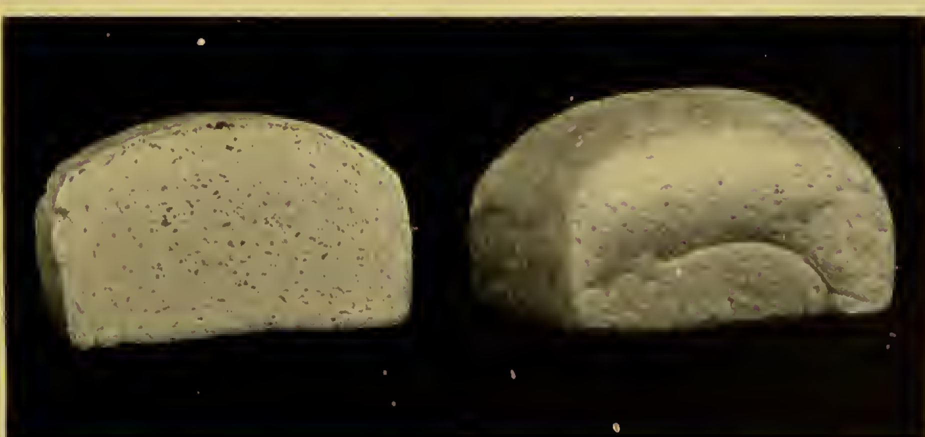


1. MALT BROWN BREAD



2. MALTED BROWN BREAD

3. RYE BREAD



4. SPICED RYE BREAD

BROWN AND RYE BREADS

1875 by Pooley and by Oliver, the bread being sold as *Pooley's* or *Oliver's brown bread*; but the originality of the process has long been matter of dispute. Without keeping strictly to the quantities given in either case, the following method and quantities may be accepted as making very palatable bread. One pound of ground malt is made into a paste with about 1½ pint of water, and placed in a stoneware jar. This jar in turn is placed in an iron pot with a lid, containing sufficient water to come up to about 2 in. from the top of the jar. This apparatus is then placed in the oven, generally after the bread for the day has all been baked, and allowed to remain there for 5 or 6 hours. During this time a good deal of the water will evaporate, and it may require replenishing in the outer pot; otherwise there is a danger that the malt in the inner jar may become dry, in which case it will burn and be spoiled. The process intended is to cook the malt by stewing at the temperature of boiling water for a considerable period. This prolonged boiling entirely destroys the diastasic properties of the malt, so that, except for the ingredients it already contains, it has no chemical effect upon the materials of the dough at the subsequent stages of bread-making. This method of preparing the malt decoction is somewhat primitive, but is effective for the end desired, nor is it an inconvenient method for the ordinary routine work of the bakery. In many cases where old-fashioned ovens are in use, it is considered necessary while the bread is baking to keep a pot of water in the oven to compensate for the loss of steam through cracks in the brickwork. In such cases the malt pot serves the double purpose of preparing malt for brown bread and also of supplying an atmosphere of steam in which to bake the white. When the malt is thus prepared it may be cooled either by standing, if that is convenient, or by mixing with the cooler water necessary for making dough. The quantity of malt specified will be sufficient to use with 8 lb. meal and 2 lb. flour. This has 8 oz. lard well rubbed into it. Straight dough is made with 3 oz. yeast, 2½ oz. salt, 1 oz. bicarbonate of soda and 1½ oz. cream of tartar, and 5½ pints water, including that in the malt paste. The dough is allowed to stand covered up in a warm place for an hour and well kneaded, then scaled off in, say, 1-lb. pieces, cut on top, and baked under covers (Plate Brown and Rye Breads, fig. 1). The loaves will require from 45 to 60 minutes to prove, and must not be baked in a very hot oven; otherwise they take too much colour. The principal ingredients which this malt decoction brings to the bread are the sugars of malt—glucose and maltose—as well as a considerable quantity of dextrin, and some starch much boiled, but not changed. The sugars keep the bread very moist, but rather hinder than help the fermentation; hence the necessity for a comparatively long proof. As already noticed, the malt, by prolonged boiling, has lost all its effect on the starch of the meal while baking, but it contains sufficient sugar of its own to make the bread sweet, whilst the malty flavour is

Use of Malt Decoction.

Quantities for Dough.

Ingredients in Malt which affect Bread.

very pronounced. This kind of bread, when properly made, has a ready sale, and customers keep to it with fair constancy.

A more scientific method of preparing malt brown bread is by the use of malt extract. This is prepared in vacuum pans from crushed malt, in the form of a thick syrup. The malt decoction in this case being boiled and concentrated at a temperature much below that of boiling water, and below that at which its diastase is destroyed, that diastase remains active, and, being in a concentrated form, is capable of changing gelatinized starch into sugar. For bread of this kind the following method may be followed. 1½ lb. of flour is mixed into a paste with 3¼ pints of water at 170° F., care being taken to prevent lumps. Into this paste ¾ lb. of pure malt extract, or at least one of standard diastasic strength, is stirred, and the paste thus made is allowed to stand about two hours in a warm place, or until such time as its temperature has cooled to about 100° F. A straight dough is then made with 6 lb. wholemeal and 2 lb. white flour, into which has been thoroughly mixed 1 oz. bicarbonate of soda and 2 oz. cream of tartar; 2 oz. lard is well rubbed into the meal and dough made straight off with the paste already prepared, 2 oz. salt and 3 oz. yeast. This dough is then allowed to stand for about one hour, when it is kneaded and scaled off—for small sizes in 1-lb. pieces, and for large sizes in pieces weighing 1 lb. 12 oz. Loaves are at once moulded oval, and placed on clean baking sheets, which do not require greasing, but may be slightly dusted with meal (Plate BROWN AND RYE BREADS, fig. 2). The tops of the loaves should be slightly cut, and covers then neatly placed over them. One cover should be allowed to stand, open end upwards, while the loaves are proving, so as to judge accurately when they have had sufficient. If kept in a moderately warm place they should be ready for the oven in from thirty to forty minutes. On account of the chemicals contained in the meal, these loaves do not require so much proof as ordinary wholemeal: about 1¼ in. from the top of the cover that has been left mouth upward is usually quite sufficient to make the loaves fill the covers properly, so as to be flat and nicely coloured on the top, with the top edge only rounded and paler in colour than the remainder of the top. There is, of course, no need to use the oval covers usually associated with malt bread, but ordinary oblong open tins may be used instead, and a good many customers really prefer these. In this case, as the tins do not themselves supply a guide as to when the loaves are sufficiently proved, care has to be taken that they are not allowed to over-prove; otherwise they are likely to have a large hole in the centre or else under the top crust, and will probably be crumbly and wanting in flavour. The use of soda and cream of tartar in this and the preceding mixture is to assist in aerating the bread in a reasonable time, since a large quantity of malt extract as well as the preliminary paste made with flour, part of which has its starch gelatinized, prevents the yeast from working actively. With the addition of the chemicals a smaller proof is required before the bread is set in the

Malt Extract.

Malt Extract Bread.

oven, and yet the maximum bulk and lightness are obtained. But these chemicals are not absolutely necessary; only if not used it is advisable slightly to increase the quantity of yeast.

Owing to the large quantity of sugar in this bread—in the malt extract used as well as that produced by the action of its diastase—it requires to be thoroughly baked, yet not in a hot oven, or there is a danger of its being dark-crusted before the centre is done. In an oven at 430° F. the 1-lb. size will bake in about thirty-five minutes, whilst the larger size will require from fifty to sixty minutes. Bread made in this way is somewhat sweet, but has a pleasant malty taste. This is, of course, due to the flavour of the comparatively large quantity of malt extract used, and this flavour is intensified by the maltose sugar produced in small quantity from such of the starch as has been burst in the paste made in the preliminary process. This sugar indicates its presence in the dough by a very slight stickiness. But, in addition, as the diastase of the extract continues active for some time after the bread is in the oven, a small quantity of maltose is probably also formed there.

Malt Flour.

Malt flour is now sold to bakers for using either in white or brown breads. The method of using in brown is similar to that already explained under the title of Oliver's Brown Bread. Malt flour, being fine, is better suited than malt meal for this purpose. It not only does with much less stewing as a preliminary operation, but, being free from husks, can be better mixed in the bread without betraying itself as a foreign substance, and, weight for weight, it of course gives a greater flavour. For malted brown bread made with malt flour use 1 lb. malt meal for each 10 lb. of prepared meal—8 lb. wholemeal and 2 lb. flour—required. The malt flour may be stewed in the oven in the manner already described, or if that method is inconvenient, it may be stewed over a stove in a double pan, the outer one containing water, for about half an hour, being well stirred while on the stove. The flour is made into a thick paste, placed in the inner pan, and then boiled as described. The use of the outer pan with water is to prevent the malt from sticking to the bottom and burning. Its temperature, by the use of such an appliance, does not rise above the temperature of boiling water. When the stewing process is completed, the malt paste is cooled down, either by standing or by the addition of cold water, to 100° F. A straight dough is then made with 8 lb. wholemeal and 2 lb. fine flour, with which is incorporated 1 oz. of soda and $1\frac{1}{2}$ oz. cream of tartar, and into which 2 oz. of lard or other fat has been rubbed; $2\frac{1}{2}$ oz. of salt and 3 oz. of yeast are thoroughly mixed in the bay with 2 quarts water, besides that used for the malt paste. This dough, when made, is allowed to stand in a warm place for one hour, after which it is kneaded, scaled off, and moulded into tins or under covers similar to those generally used for malt bread. One cover should be left mouth upwards to note the extent of proof. As there are chemical aerating agents in this dough, the loaves should be proved up to about

Quick Method of making Malt Paste.

$1\frac{1}{2}$ in. from the top of the open tin; otherwise they will not completely fill the tins, and will look poor in consequence. This method of making malt bread gives very satisfactory results in the matter both of flavour and appearance.

A note has been already made about the constitution and properties of wheat germ. It may be obtained from those millers who take pains to separate it in a pure state—some millers simply run it in along with the bran and offal—as some do when there is any demand amongst their customers. The following ingredients and quantities are used for germ bread: Fine flour, 6 lb.; germ, 2 lb.; yeast, 3 oz.; salt, 2 oz. There is no need for either extra fat or sugar, as the germ is itself oily and sweet. These ingredients are made into a soft dough with 2 quarts and $\frac{1}{2}$ pint water at about 104° F. The dough, made tough by mixing, is allowed to lie about twenty minutes, after which it is well kneaded, and weighed into small oblong tins about 7 or 8 oz. in 1*d.* size. These will require about forty to forty-five minutes to prove, and, if small size, will bake in about thirty minutes in an oven at 430° F. This bread will be lighter and brighter in colour than that made from the meals with registered names which also contain wheat germ.

Fresh Germ Bread.

Amongst this latter class of breads the oldest form and best known is *Hovis.* This name is formed from *homo,* man, and *vis,* force, and, of course, gives no indication of the composition of the meal or bread. It was, when first introduced, simply called *Germ* bread, but as this title could not be registered, and might therefore be used by anyone, the name Hovis was adopted. In this case the wheat germ is used in about the same proportions as given above for germ bread, but in Hovis the germ is subjected to a preliminary heating or roasting process before being mixed with white flour. For Hovis, the following quantities and method may be adopted: Hovis prepared meal, 8 lb.; yeast, 3 oz.; water, 2 quarts and 1 pint at 106° F. No salt is required, because, for reasons stated above, it is already mixed amongst the meal. The dough is very thoroughly mixed and toughened and then allowed to rest for about twenty minutes, after which it is again kneaded, and then weighed into tins. These, kept in a moderately warm place free from draughts, will prove to within $\frac{1}{2}$ in. of the top of the tins in from 30 to 40 minutes. They are then baked in an oven about 440° F. Small sizes will bake in 25 minutes; 2*d.* sizes will require from 30 to 35 minutes; and 3*d.* sizes, weighing about $1\frac{3}{4}$ lb., will require from 40 to 50 minutes. This method is not identical with that usually followed, and considerably different from that given in the instructions by the firm supplying the meal, but the writer has found it gives most satisfactory results in texture and in flavour. In the instructions supplied, the water used is much hotter than this, and the loaves are weighed and placed in tins almost as soon as the dough is made. From this two serious

Hovis Bread.

Preparation of Germ.

Method of Dough-making.

faults very frequently follow. The texture of the bread is very open and honeycomb-like, and it is tough and deficient in flavour. These results are caused by the yeast remaining wholly in one spot in the dough, as the loaves cannot be kneaded a second time after they are placed in tins. On the other hand, by the method suggested above, the second kneading increases very much the number of threads of gluten in the dough, renders it more ductile and makes its threads much finer, and increases the number and therefore reduces the size of all the vesicles of the dough, thus giving a much finer texture. To this end even more than one kneading is advantageous, if only short intervals are allowed between them, and in any case the dough with this proportion of yeast should not lie longer than half an hour before scaling; otherwise there is a loss of flavour. Some bakers, acting on instructions received, make the dough so soft that they cannot handle it without adopting the continental custom of keeping the hands wet by dipping them into water while scaling off and handling the pieces. This is distinctly awkward, and the resultant bread is not as well flavoured as that made from dough stiff enough to handle in the ordinary way.

Texture of Hovis.

How to improve Texture.

Daren bread is in all respects so much like Hovis that the instructions given for the latter are equally applicable to the former, or, indeed, to all meals in which germ forms a considerable part. Within the last year or two an effort has been made to use these meals, minus the salt, for cakes, gingerbread, and ordinary currant bread, but their popularity for these purposes does not increase, nor is it likely to, as, except for biscuits, they are not well adapted for such uses, and the taste of these meals is no enhancement to such goods made from white flour.

Daren Bread.

Special Meal for Cakes, &c.

An excellent cheap biscuit can, however, be made either by using fresh germ or any of the other meals mentioned, although fresh germ gives the best results on account of the absence of salt, unless, of course, the meal with the registered name is obtained specially for such a purpose without salt. The quantities are as follows: 8 lb. white flour, $2\frac{1}{2}$ lb. fresh germ, 1 lb. 14 oz. lard, or $1\frac{3}{4}$ lb. vegetable fat, $1\frac{3}{4}$ lb. sugar. In the white flour before mixing with germ, 2 oz. bicarbonate of soda and 4 oz. cream of tartar are mixed and sifted twice. The dough is made with 3 pints of milk, either fresh milk or butter milk. This dough is "pinned" out in small pieces at a time in sheets about $\frac{1}{8}$ in. in thickness, and cut with a round, oval, or oblong cutter as desired, but for plain goods of this description plain cutters are preferable to those with crimped edges. The table should be dusted as required, not with flour but with wholemeal. The tins do not require greasing, but must be thoroughly cleaned. These biscuits should be baked in a warm oven—about 440° F. They are crisp and very nice-flavoured biscuits and sell well.

Brown Biscuits.

Exactly the same mixture is suitable for making wholemeal biscuits, only there is no fine flour mixed with the meal in that case.

Wholemeal Biscuits.

The very best mixture for this class of biscuit consists of half oatmeal (medium cut) and half wholemeal, the other ingredients in dough as above, only that a little more milk is required when oatmeal is used. When several sorts of brown biscuits are made, it is a convenient arrangement to have each distinctive kind cut a different shape from the others to save confusion.

Oatmeal Biscuits.

Amongst brown breads that made from rye may be classed, although the sort now referred to is brown on the outside only and greyish in crumb. There is not much of this kind of bread demanded in this country, except by some German and Russian Jews (see Plate Brown and Rye Breads, fig. 3). It is not like the black bread of Germany or the Dutch rye bread (see Plate Dutch Bread). The following quantities and methods will be found to give good results. Rye flour and wheat flour are mixed together in equal proportions, and of this mixture 5 lb. is weighed. This is made into dough with 1 quart water at 104° F., 1 oz. salt, and 1½ oz. yeast. The dough is allowed to lie one hour and is well kneaded, then at the end of another half hour it is kneaded again, and weighed into pieces of the size required. The loaves are generally either 1 lb. or 1½ lb. They are moulded round or oval or long, and allowed to prove either on cloths upside down or on dusted boards and covered over with cloths. This dough will be quite firm, and the loaves will require from 1 hour to 1½ hour to prove, and will then not be very bulky. When ready for the oven, they are thickly smeared over with a paste made by scalding 1½ oz. of cornflour in 1 pint of boiling water. The oven should not be above 420° F. When the loaves are nearly baked they are drawn to the mouth of the oven, and washed over a second time with the starch paste and returned to the oven to dry. The result of this second application of paste is to give the bread a very dark highly-glazed crust, which, however, is usually rather tough. The texture of the crumb of this bread is very close, but the bread is sweet, and to those who acquire a taste for it is satisfactory. It keeps moist for quite a week. To those unfamiliar with the taste of rye it is not particularly enticing. Made in the way described, it does not acquire the decidedly sour taste so characteristic of rye bread made by the leaven process or from a long sponge, but it has a mawkish sweetness which soon becomes nauseous. This kind of bread when made for special customers is generally sold at 3*d.* for about 1¼ lb.

Rye Bread. **Paste for Glazing.**

Another sort of rye bread which usually contained a small quantity of spice was common as a kind of cheap gingerbread in Scotland many years ago, and may still be found in isolated places. A modern method with yeast is as follows (see Plate Brown and Rye Breads, fig. 4). Make straight dough with 2½ lb. rye flour and 2½ lb. white flour, 1 oz. salt, 4 oz. golden syrup, 2 oz. yeast, ½ oz. mixed spice, and 1 quart and 1 gill water at 104° F. The syrup is mixed with the water in bay, then salt, then yeast is added, and straight dough made. This is allowed to rest in a warm place for an hour and then well kneaded.

Spiced Rye Bread.

It is weighed and moulded at once into tins, as the dough is comparatively soft. Owing to the syrup these loaves prove rather slowly. In about 1 hour or 1¼ hour they will be ready for the oven, which should be rather cool. This kind of bread is very palatable and finds a ready sale for a time, although customers ultimately become tired of it. One characteristic it does show much like gingerbread: it should not be eaten new, as it keeps soft and moist for a long time according to the moisture in the atmosphere, becoming soft whenever the air is the least damp. The old-fashioned method of making this bread was to bake it in large blocks weighing about 6 lb. each, but for modern requirements it is better to make it in small loaves and sell as a speciality, charging of course a special price.

Keeping Properties of Rye Bread.

Several of the sorts of brown bread mentioned above are proprietary articles, and the names under which they are sold are registered trade marks, which cannot be used except by authority of the proprietors, and the use of the registered names otherwise, even if the bread is identical with that to which the name applies, renders the user liable to a penalty. While therefore Hovis and Daren bread cannot be sold except by the leave of the proprietors of the respective meals, there is nothing to hinder any baker from making germ bread in the manner described above, and selling it, either as germ bread, or under any special name he may choose. The same thing is true of brown breads prepared with a proportion of malt meal, flour, or extract. These substances can be used in any manner and in any quantities, but the bread produced can only be sold under a registered name by the sanction of the proprietor of that name. This caution is necessary because some bakers think if they use the same ingredients as those in a "patent" bread, that they may sell it under the name the patentee has registered. On the other hand, some are afraid to make fancy brown breads of their own, because of a fear of infringing some other patent. Only the registered name is really protected, and the conditions attached to the name, but neither process nor ingredients carry any exclusive rights. In the case of some proprietary breads, such for instance as Bermaline, the patentees are particular that the bread sold under their title must contain all the ingredients stated in their process, and in the proper proportions. To this end the proprietors send out instructions to bakers who desire to make their bread, the condition being that all the ingredients are purchased from this firm. At one time the wholemeal semolina and malt extract used in the manufacture of Bermaline bread were sold separately, the baker being instructed to mix the chemicals in the meal in certain proportions. Owing, however, to carelessness in the bakery, the ingredients were often mixed in anything but their proper proportions, with the result that great variations in the bread, as made by different bakers, were destroying the reputation of Bermaline as it should be made. To remove this trouble the proprietors do not now send out the ingredients separately, but prepare and mix the meals in their proper proportions, adding also the chemicals, and supplying a malt extract of

Proprietary Patent Breads.

standard quality to use according to the instructions. The process is much like that given above for malt bread, but, as already stated, it must be made from materials supplied by the Bermaline firm; otherwise the name cannot be used.

Quite a number of large millers now prepare special meals for bread with registered names. In a good many cases these meals are mixtures of white flour and wheat germ only; in others the meal contains a quantity of malt flour, either from barley malt or from malted wheat itself. The actual contents are kept as much as possible secret. Some of these special breads are worthy of note because of their pleasant flavour, although their process of manufacture is difficult. Two such breads are *Carr's Malt* and *Veda*. When the former was first introduced to the trade a considerable quantity of syrup was given in the instructions as one of the necessary ingredients, and a good many bakers who took up the license to make this bread found it impossible to bake it. The syrup, or the greater part of it, is now left out of the mixture, so that the bread can be easily made in the ordinary way. The writer has found the simplest plan, to obtain best results, is to use 1 oz. yeast to each 3 lb. meal and let the dough, made rather firm, stand three-quarters of an hour, then knead well and mould. The tins for this bread have no bottoms, but are oval rings with the name embossed on the side. The loaves are cut on top. They take about half an hour to prove, and are then baked in an oven about 360° F. for $1\frac{1}{2}$ to 2 hours. The special point about this sort of bread is its malty flavour, and its keeping qualities.

Carr's Malt Bread.

The other bread mentioned above, Veda, is made from a special meal consisting of about two-thirds white flour and one-third Veda meal. The proprietors, meeting the same difficulty as mentioned above with regard to Bermaline, tried the method of sending out the meal and flour already mixed, but discovered that the bread prepared from such mixture had not the pronounced flavour of that made by the original process. This consists in making a strong sponge with, say, 4 lb. flour, 2 quarts water, and 3 oz. yeast. This would rise and turn in about 45 minutes, when it is made into dough with 6 lb. flour, 1 pint water, 3 lb. pure Veda meal, and $2\frac{1}{2}$ oz. salt. The dough is allowed to lie about an hour, then well kneaded, weighed, and moulded into tins. Another method is to make the white dough first, either by sponge as above described, or by straight dough process, using the same ingredients; then when the dough is nearly ready for scaling, to work in the Veda meal, and then scale and hand up, allowing to lie some time before moulding into tins. Another plan is to make dough with all ingredients as described, then to re-knead it in the machine—if the quantity is large enough—and after allowing the dough to recover, to mould into tins. The loaves are then allowed to prove in the usual way, until they are nearly level with the top of the tins, and are baked in an oven at 320° F. for about 3 hours. The variety of methods for making this bread are the result of efforts made by different bakers to overcome the difficulties which arise. The great trouble is to secure an

Veda Bread.

oven cold enough, that can be used for such a long period as 3 hours. The best plan is to have the bread ready for the oven after all the other work of the day is finished, then to appoint someone to take it out at the stated time—at the end of 3 hours. The time of baking must be judged by the clock, because the loaves, whether baked or not, have a rather thick crust and are hard, while the centre may be still soft and sticky, so that its readiness cannot be judged by ordinary bakehouse signs. The thickness and hardness of crust at the sides may be reduced by allowing the loaves to bake close together, so that baking is done by top and bottom heat only The softness of the interior is more difficult to overcome. This is of course due to the excessive action of the diastase in the Veda meal, which changes so much of the starch of the flour into sugar during baking that the interior of the loaf becomes extremely difficult to dry. On this account, even when the loaves are properly baked, this bread is never cut for use till it is at least 24 hours old. Bakers have not taken up agencies for this sort of bread with the same freedom as in the case of some others, owing solely to the difficulties in manufacture; yet when it is made with care it is probably the best flavoured of all the proprietary breads now on the market, and those who are able to make it successfully find that it sells well as a speciality. These loaves are baked in ordinary oblong tins, in 1 lb. or 1½ lb. sizes, with the registered name embossed on the sides.

Bran Bread.

A note was made above about bran bread, which is still ordered by doctors in cases of dyspepsia or chronic indigestion. This bread may be made a good deal lighter than ordinary brown and be rather nice to eat. The following method may be followed. Make straight dough with 8 lb. fine flour, 2 lb. clean bran, 4 oz. lard, 3 oz. sugar, 3 oz. yeast, and 2 quarts 1 pint water at 104° F. This dough will be moderately soft. Allow to lie one hour, then knead thoroughly, and knead again in another half-hour. The dough should then be ready for scaling into 2-lb. pieces. Instead of baking these in single tins, four may be placed in a large round tin about 14 inches in diameter with a lid. The loaves are well greased on the sides so as to allow them to separate easily when baked. These are allowed to prove until about one inch from the top of the tin—this should take 30–35 minutes—and then baked with the lid on. The loaves will then be of the same thickness throughout but triangular in shape, rounded on one side and straight on two others. This shape makes a distinction from ordinary brown bread, and finds favour with customers.

CHAPTER XXIII

MANUFACTURE OF HOME-MADE BARMS AND YEAST

Mention has been frequently made in preceding chapters of home-made barms and their use, and it may be convenient to deal with them here, **Malt and Hop Barm.** especially as there are still many places, in tropical and subtropical countries, where one or other sort must be used. Of home-made barms the easiest to prepare, and probably the most reliable, is that made from malt and hops. This barm is given different names in different localities. In Scotland, where it was at one time universally used, it is known as "compound" or "comp" barm, while in London the term used is "patent". The method of manufacture and quantities of materials vary almost with the number of bakers who make it, but there is general agreement on the main points. As a matter of historical interest, **Variations in Manufacture.** and as showing how persistently a trade keeps to its methods for very long periods, the description of this process of barm-making, as given by a baker who published a work on the subject in 1830, may be inserted before the method still in use, which really differs very little. Under the title of artificial malt yeast this author writes: "Take 5 gal. of soft water, adding 2½ or 3 oz. of hops, or 1½ oz. of pounded gentian-root, or **Old Method.** twopenceworth of red sage; let either of these boil for 20 minutes or ½ hour slowly, and cool this down to 170° or 180° F. according to the state of the malt, then take 5 lb. of rough ground malt, and mash it with this liquor for 2 hours, and then press out the grains with your hands, or with a screw press made for the purpose, and when your wort is cooled down to 65° or 70° according to the state of the weather, add two or more quarts of artificial yeast (from a previous making, similar to that now described), along with 3 oz. of salt and 1 lb. of fine flour, and let the whole fermentation go on till it has completely ceased working, when it is ready for use. This yeast, like all other artificial yeasts of the kind, is often better the second day than the first, and this may be accounted for by the circumstance of the fermentation not having completely ceased. Some are in the habit of fermenting their grains along with their yeast, but it is by no means a good plan, because they are very apt to get into **Old Mistakes.** an acetous or sour fermentation, instead of a vinous or sweet fermentation, which is much preferable. It is a common practice with many bakers to put the salt into the boiler along with the water and the hops. Now, can there be anything more inconsistent or absurd? for they have no sooner got the softest water they can procure for this purpose, than they will immediately clap in a parcel of salt, which will of course render it hard, soft water being universally approved of, as being best adapted for all manner of brewing whatever. By no means cool your hop liquor down with cold water, which I have known some people do: it has a tendency to bring the whole into a raw state. Always use your thermometer as a guide in making your yeast."

This process would, of course, make good barm still, only the temperature for storing is 6° to 8° too low to obtain a vigorous fermentation. Boiling salt with the hops and water does not increase the hardness of the water, as we now use the word, but it has the same effect in barm-making, inasmuch as it reduces the solvent action of the water on the malt, and the wort will in consequence contain less extractive matter.

Salt does not harden Water.

The common practice as now used is as follows. From 2 to 3 oz. of hops is boiled for about 10 minutes in 5 gal. of water. After stirring, and when the hops have sunk to the bottom of the boiler or pan, it is allowed to cool to 170° F. When this temperature is reached, 14 lb. of crushed malt is stirred into the hop liquor, until all is properly wetted. It is then covered up and kept in a warm place, where the heat will remain from 140° to 150° F. for about 4 hours. The liquor is then strained from the grains, the latter being well pressed between the hands, or in a proper press for the purpose. This liquid is the barm proper, and only requires to be stocked with yeast. The quantity of barm from a previous making necessary for this purpose is about 3 pt., or, roughly, 3¾ lb. The temperature of the barm after storing should be about 74° F. in summer and 80° F. in winter. When stored or stocked it should be well stirred and aerated, as this starts fermentation quickly, and aids the production of new yeast. If the barm is wanted in a hurry no salt should be used at the time of storing, but in the ordinary course the addition of 4 oz. of salt to this quantity will steady fermentation, and prevent exhaustion and subsequent sourness.

Modern Practice.

Stocking or Storing Barm.

The next point is to make provision for keeping the barm warm and as regular in temperature as possible. During the first four or five hours the temperature will actually increase, owing to the extreme fermentative activity of the yeast cells, and as it is important that this chemical activity should not be reduced, care has to be taken that the tub is kept in a moderately warm place in cold weather, or, otherwise, that it is well protected to conserve the heat generated within. As fermentation proceeds, the yeast cells increase in number, and, for a time, form a seething mass within the liquid, and a thick scum on the top; but as the process continues, the gravity of the liquid becomes less, and the gas-producing activities of the yeast cells slower, and as the cells themselves minus the gas bubbles which adhere to them are heavier than the liquid in which they have been working, they gradually sink to the bottom, forming a layer there, and the top and liquid underneath become comparatively clear. When this clearness begins to show as small white bubbles through the dark scum which up to a certain stage covers the top, this is roughly a sign of readiness, although appearances depend a great deal on the kind of malt used. In any case barm is not ready for use until it has been fermenting roughly for about twenty hours. Some bakers do not use the thin top liquor, but, as long as the barm is new and fresh, it is as well to stir the whole together, and use the

Keeping Barm.

Signs of Readiness.

total liquor. The liquor itself is not of assistance in the fermentation of dough, except for the ripening or softening action which the acid matter it contains may have on the gluten of flour, and, in the case of that from which yeast foods, saccharine and proteid, have not been exhausted, in continuing to supply these to stimulate and quicken yeast activity. The main point to notice, however, is that the quantity of liquor used is not the determining factor in the amount of fermentation which will result, but only the quantity of yeast cells which the liquor actually contains. Thus the same measure of liquid, if highly nutritious for yeast, may contain many more cells than a thin and innutritious liquid, while for either kind of liquid a difference of a few hours in its age may make a considerable difference in its fermentative strength, as yeast keeps on growing in quantity the longer it is working in a suitable medium. From these considerations it will be evident that variations may readily arise in the strength of barm, and still greater variations in the results of dough fermentation which it produces, and these variations may be difficult to control or even to explain.

Why the Liquid Part of Barm is used.

Strength of Barm is in Yeast.

Variations in Strength.

There may be in cases a strong sentimental reason for the baker to continue making and using his home-made barm, but, except in circumstances already alluded to, where factory-prepared yeast cannot be obtained, it is really an unwise policy. The baker has so many other operations to attend to, which require constant watchfulness and regulation by the clock, that he is well rid of barm-making, which is the most important and critical of all his work. It is not, as sometimes suggested, a question of the want of scientific knowledge on the part of the baker, or of superior knowledge on the part of the yeast manufacturer, but only that in the yeast factory the prime purpose is the proper care of the yeast, and everything is made to subserve that end, whilst in a bakery, important as barm-making is, its various stages have to wait on the more immediate necessity of getting the daily supply of bread right, and in consequence may be partly neglected. This is the case particularly in small bakehouses, where the man who looks after the barm is also the working baker. In large establishments, where one man may have barm-making alone as his special duty, the work can be done much more satisfactorily, but its use even then is not so safe as compressed yeast, for, within limits, the number of yeast cells in a given weight of the latter is always alike, whilst the number in a given measure of the liquid may vary considerably. Amongst liquid barms, that made from malt and hops is probably more satisfactory than any other, and gives least trouble in its manufacture.

Why Bakers should not make Barm.

The quantity to be used in a quarter or half sponge has been already indicated, as from 3 to 4 or 5 imperial pints per sack of flour, according to the strength of yeast and the time it has to stand, but the same barm gives satisfactory results with straight dough. The best period to allow a straight dough to lie is about eight

Quantity of Barm per Sack.

DIRECTORS OF THE BAKERY AND ALLIED TRADES EXHIBITION

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Herbert Scofield Rogers is Assistant-Manager and Secretary of the Trades, Markets, and Exhibitions Limited. Mr. Rogers was born in 1876, and was educated privately and at London University. He had two and a half years' training as an electrical engineer, but gave up that business when he became Secretary of the Exhibitions in 1895.

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DIRECTORS OF THE BAKERY AND ALLIED TRADES EXHIBITION

hours. The quantity of barm of the above strength to clear the dough in this time is about 3 or even 4 quarts, the temperature of the dough being not above 78° F. For the first two or three hours the dough seems very sluggish, but it comes on very vigorously afterwards. It should be well kneaded, if possible, at the end of six hours. The resultant bread is not bulky, but is quite clear and of pleasant flavour, the crust having also a nice bloom. With such barm the writer on one or two occasions has had to make small quantities of bread in about three hours from start to finish. By using sufficient yeast, keeping the dough warm, and kneading frequently, no difficulty was experienced, and the bread was of good volume and excellent appearance, only with the least suspicion of a barmy flavour.

Straight Dough with Barm.

CHAPTER XXIV

FLOUR BARMS

Flour is frequently used as one of the ingredients of the barm described in the foregoing chapter, but the term flour barm is generally confined to that in which flour forms the principal ingredient, as in the kinds called "Parisian" and "Virgin", which are used so extensively in Scotland, and are modified forms of compound and leaven respectively. It has been repeatedly suggested that the mode of preparing flour barm was originally introduced into Scotland from France, and, considering the close relations which formerly existed between the two nations, this is quite possible; yet it is more than doubtful if there was ever any formal introduction of the barm, and there is certainly no direct evidence on the point.

Parisian and Virgin Barms.

The old author already quoted from, who published a work in 1830, was quite familiar with the flour barm we now call Virgin, and thus explains its introduction:—"About thirty-five years ago (about 1794), when brewers' yeast or barm could only be obtained by chicane and bribery, and when that which was so obtained was often unfit to use, the bakers had prodigious difficulties to struggle with, now happily unknown. Necessity, the mother of invention, at length led them to think of a substitute, which they termed 'ferment', for making which the following was the recipe:—Take 5 gal. of water, along with 3 or 4 oz. of hops, and boil for half an hour, then strain the boiling hop liquor into a cask, over about 8 lb. of fine flour, which beat up properly into a thick paste or batter, which tastes very sweet. Allow it to remain until it becomes almost cold, then add a small quantity of brewers' yeast the first time (but itself afterwards), and set it fermenting, and after it has ceased working, use it in setting sponges. I have often set it going of its own accord, without any stock of itself, or any yeast

Old Method for Flour Barm.

or barm whatever. . . . I have often seen a good-looking, passable loaf made from it, but it had when coming out of the oven a rank disagreeable smell, which went away as it cooled."

Virgin barm is still extensively used, particularly in the west of Scotland. Some makers use hops, but the majority confine themselves to scalded and raw flour only. The following description of the method of making and using Virgin barm is by Mr. Jas. Howie, Kilmarnock, and was published in the *Baker and Confectioner* as part of a lecture at the Ayrshire bread-making classes. "The barm is made three times a week, 14 lb. of flour in each scald, and the mode of procedure is as follows. The scalding-tub is first thoroughly warmed with boiling water; with the 14 lb. of flour, 4 (Scotch) pints (about 18 lb.) at 120° F. is stirred and made into a tough batter. To this is added 1 pint ($4\frac{1}{2}$ lb.) of boiling water at a time, until 6 pints (27 lb., about $2\frac{3}{4}$ gal.) altogether is used. As each pint of water is added, the batter is stirred very vigorously with a long stick, so that every particle of the flour becomes gelatinized. It is then put out of the way in a place where the temperature is between 70° and 80° F., till the next day, when it is stored by adding 2 lb. more flour and 2 Scotch pints of old barm, and it is again stirred vigorously with the hand to thoroughly mix the newly-added flour. It is then covered up and allowed to lie till the next day, during which time it will rise and fall twice before it finally clears off and is ready for using, the whole process from start to finish occupying about fifty hours. Soft flours are most suitable for barm of this type. . . . In making bread with this kind of barm a little less yeast than usual is employed—about $4\frac{1}{2}$ lb. per sack. To a batch of 20 doz. loaves ($1\frac{1}{4}$ sack) a 5-pint 'quarter' (about $2\frac{1}{4}$ gal.) is allowed, with 4 oz. salt and 2 pints (nearly a gallon) of barm. This is 'set' at four o'clock in the afternoon at a temperature of 90° (water), the bakehouse being about 68° F. It is generally about its height at ten o'clock at night, and at five o'clock in the morning it is just turned. The half-sponge is then set with water at 90°, and in two hours it is ready to lift. After it is doughed it is allowed to lie about forty-five minutes, when it is weighed off and got into the oven at ten o'clock, and is drawn at twelve — the whole process occupying exactly twenty hours." This may be taken as the regular method in dealing with this barm, the times between being filled up with preparing the small goods and biscuits which form a part of the routine work in nearly all Scotch bakehouses.

New Method for Virgin Barm.

Quantity of Barm in Batch.

The barm called Parisian differs from Virgin in having a quantity of malt decoction in its composition as well as scalded flour, while it differs from compound in having scalded flour as well as malt. The following description of Parisian, by Mr. Thomas Blair, Dalry, Ayrshire, is also quoted from the *Baker and Confectioner.* "Put 4 Scotch pints of boiling water into a small tub or pail, and when it has cooled down to 170° F. stir into it 6 lb. of crushed malt, and cover it up, say, at nine o'clock in the morning, and let it stand till

Parisian Flour Barm: Modern Method.

three o'clock into the afternoon. Into a pot or boiler run 8 Scotch pints of water, and boil this, having 1 oz. of hops in a small muslin bag in the boiler. The malt in the tub is then strained from the liquor through a brass sieve. About 2½ Scotch pints of boiling water is then added to the malt liquor to bring it up to 130° F. (in winter 140°), then into this 32 lb. of barm flour is mixed and made into a stiff batter. When the other water is boiling, one man must dip out the water while another stirs the batter; put in 1 pint and stir hard, 2 and 3 and keep stirring, then 5 half-pints, stirring hard all the time. This should make the 'scald' right. It should be thick, changed in colour (brownish), and have a sweet taste. It should not get more water, it will become thin enough as it stands. Allow this paste to lie till next morning, and 'store' at 79° or 80° F. with 1½ Scotch pint of good barm, but no raw flour; let it stand till next morning. It should have risen 6 or 8 in. in the tub and fallen again. Divide it then into three large jars and keep cool. It is ready for sponging two days after it is made. Two pints (nearly 1 gal.) barm and about 3 gal. water for quarter-sponge for 1 sack flour."

Mr. Blair gives some details of how he succeeds in curing faults from time to time. He says: "This barm may keep good for months (not one lot, but consecutive makings), but there is always a tendency to get sharp to the taste, or, in other words, get a little 'hard' wrought. Whenever I notice this, before I 'store' the next making I run off 3 Scotch pints of the liquor, then store and set this aside for six or eight hours, then pour it in cautiously without stirring, and let it stand the usual time. I have never found this to fail in sweetening and improving and putting vigour into it. I have occasionally made a new 'store' as follows:—When your barm is ready for storing, run off 2 Scotch pints into a small jar. Store the remainder of the barm as usual. Into the 2 pints set apart stir 12 oz. of raw flour and 12 oz. of sugar, and set away in a cosy place for twenty-four hours, then give it a good beat up with your hand and allow to lie covered up for another forty-eight hours, when it will be ready for 'storing' the next lot of barm, but, if not sure of it, add ½ pint of barm to it and it will be right. . . . I would suggest that hops be always used in your barm summer and winter; it does not so readily become acid. The flour for barm ought to be changed occasionally, strengthening it with about half-strong flour. In hot weather it should always be kept in a cool place; otherwise it can hardly be kept right. It should not be cooled down with cold water, and should not be fermented too warm."

Preparing New Barm Stock.

It is curious and interesting that the old author already referred to had also anticipated this kind of barm; so the present method, which has been common in Scotland for only some fifty years or less, was but a revival of an older method, which is practically still as effective, and may therefore be given with advantage. It was called "artificial yeast of malt, hops, and flour", and was made as follows. "Boil 3 oz. of hops in 3 gal. of water over a slow fire for half an hour,

Old Method for Parisian.

then let it cool down to 165° F. Pour it over 2 lb. of ground malt, and let it stand for three hours, occasionally squeezing it with the hand. Strain the liquor off, and have ready 3 lb. of fine flour which has been previously scalded with 1½ gal. of boiling water, and 3 oz. of common salt; mix the whole together, and when cooled down to 70° or 80°, according to the weather, add 2 quarts of yeast from a previous making, or other artificial yeast, and let the whole fermentation go on till it has completely ceased working, when it is ready for use. To quarter-sponge with this yeast for a 12-gal. batch, take 2 gal. of boiling water, and scald 2 lb. of fine flour with it; and, when at 100°, set it pretty thick with flour and 1 quart of yeast, and after it has dropped set your full sponge. Take, then, 9 gal. more water at 100°, adding your salt and quarter-sponge with the usual quantity of flour, and, when dropped, make dough, taking up 1 or 2 gal. of cold water and the salt you require; give it an hour or more proof in dough, then scale off and lay them up, &c." This yeast contains a larger proportion of malt and less scalded flour than the more modern kind, but the principle on which it ferments is the same, while the fact that the malt decoction is not treated with the boiling water with which the flour is scalded leaves it much more active as a diastasic agent, and the addition of scalded flour in the first sponge supplies the diastase of the malt with plenty of material from which to prepare yeast food. The writer has tried this yeast, and found it produce an exceptionally nice-flavoured and bulky loaf.

Ferment with Scalded Flour.

In the case of Virgin barm made with flour only, the explanation of its mode of working is not so simple, or apparent, as in the case of the other flour barm in which malt is used. There is a small quantity of raw flour added to the barm after it is cooled, or, in the case of that which is stocked, when the old barm is added, and it has been suggested that this flour, or the soluble proteids which it contains, has the power of changing the gelatinized starch of the scalded flour into fermentable sugar, but experiments undertaken specially to discover how far this is true demonstrate that the soluble extract of flour is almost without any appreciable effect on gelatinized starch. It is possible that the acids produced during the fermentation of flour barms may assist in changing the gelatinized starch of flour. The soluble portion of the flour actually scalded is, of course, ineffective as an alterative agent, even if in ordinary circumstances it may possess slight properties of this kind, for it has been coagulated by heat. In Virgin barm to which stock has been added there may be already some enzymes which can change starch, since the extract of ordinary yeast is credited with this property to a slight degree. However the change is produced, it does occur in Virgin barm, the evidence of which is the thinning down of the barm from the thick jelly-like paste when newly made; but in this barm the change is not nearly so complete as in the case of Parisian, or other flour barm, in which malt is used.

Why Virgin Barm ferments.

What changes the Scalded Flour.

In Virgin, even when ready for use, a good deal of the starch still remains as starch, although it is changed from the gelatinized to the soluble condition—a transformation readily brought about by the intervention of acids only. The presence of this soluble starch has probably a good deal to do with the softness and slightly raw taste which is characteristic of bread made with this kind of barm. It should be remembered that in the natural sugar and other constituents of flour, not affected by scalding, there is nutriment for a very considerable growth of new yeast, apart from the sugar obtained from changed starch. It has been already pointed out in the remarks on yeast growth (Chap. XII) that a sugar solution is not the best medium in which to cultivate yeast, but one in which there is soluble proteid matter and free oxygen (or roughly, air). In a flour barm of the Virgin kind, the gluten which was in the flour is ultimately dissolved, and yeast growth may be going on rapidly, although there may not be excessive gas production, as in a medium containing much sugar. In Parisian barm there is, of course, an abundance of both sugar and proteid matter in the malt, while the diastase of the latter changes practically all the starch of the flour that has been gelatinized into fermentable sugar, by slow stages, the first operation being to change it partly into dextrin and maltose, but as the latter is fermented out by the yeast, to further change the dextrin also. Exactly the same process goes on in the case of the barm described from the old method. As already noticed, there is in all these flour barms a quantity of acid normally produced. The germs producing these acids may be inoculated by means of the raw flour used in one case, and by the malt in the others, for it is well known that the husks of malt, as well as the outer coatings of all grains, do harbour germs of one kind and another, ready to produce their characteristic acid products when placed in a medium suitable for their growth and reproduction. These acids can dissolve proteids, and aid considerably in ripening the gluten of flour when mixed in dough.

Effects of Virgin on Bread.

Sugar of Flour unaltered by Scalding.

Change in Gluten.

Acid Germs in Flour and Malt.

In preparing flour barms the first care is to prevent lumps forming. This end is attained by thoroughly mixing all the flour and a quantity of the water into a tough batter, the water used for the purpose being about 120° F., so that the batter itself may not be so cold as to reduce the boiling water below the point at which it will effectively scald the flour. In those barms containing malt, it may seem a strange proceeding to mix the malt liquor with the flour before adding the boiling water, since the active principle of malt—diastase—by which the subsequent change of starch into sugar is produced is virtually destroyed at a temperature above 170° F. But safety lies in the heat-reducing properties of the batter first made, and in the speed with which this batter and the boiling water are mixed together at the stirring

Prevention of Lumps or Knots in Barm.

Why Stirring must be quick.

operation. If the heat of the scald when newly made is tested it will be found to be very little, if any, above 170° or 180° F. Improper stirring may readily spoil this kind of flour barm by destroying the diastase of the malt.

"Spontaneous" Yeast or Barm.

In the Australian Colonies, New Zealand, and South Africa, where compressed yeast is not yet manufactured, a form of potato yeast or barm is in use, which, in the first instance at least, is allowed to start fermenting without any stock being added, and on this account the barm is called "Spontaneous", or, for short, "Spon". This seems also to be a revival of an old method, probably taken to the Colonies in the early days by some baker from the old country. Here is the old recipe.[1] "Boil 2 oz. of hops in 2 gal. of water, and then have ready 10 lb. of mealy potatoes which have been properly washed and boiled, mash them down with their skins, and, adding your hop liquor, &c., all together, put the whole aside, covered up. When at 70°, add about 2 quarts of yeast and 2 lb. of fine flour, and let the whole fermentation go on; some also add a quantity of sugar. When it has completely ceased working, put the whole through a sieve or drainer, and then use it at pleasure. This is a strong yeast; 1½ quart will bake a sack of flour. You may either quarter or half sponge with it, and it produces a sweet, fine-flavoured loaf of bread."

Old Form of Potato Barm.

Quantities in "Spon".

The following is the method and quantities used generally in making the so-called "spontaneous" yeast at present in favour in the colonies mentioned. One and a half pound of hops are boiled in 16 gal. of water; and while this is preparing, 56 lb. of sound potatoes are washed and boiled or steamed until properly cooked. When done, they are thoroughly mashed, and the hop liquor poured on to them. When this has been allowed to stand covered up for some time, 14 lb. of sugar crystals (in this country called coffee crystals, but in Australia called brewers' crystals), 12 lb. of flour which has been baked and sifted, and ½ lb. salt are added. When the whole mixture has cooled to about 76° F., 2 lb. of bran is stirred in, and the barm is then kept covered up until it starts fermenting of itself, which it does very quickly; in fact, it is ready for use in sponges or doughs in thirty-six hours from the time when it was made. It is usual to add about 2 quarts of old barm as stock for this quantity; and when thus stocked, the barm drops in about twelve hours, and is ready for use in about two or three hours more. It is a regular practice by careful bakers to reserve some of the plain mash after everything is in except stock, and to place this aside in a clean jar in a situation where it will not be disturbed. This ferments with a good head "spontaneously", and may be used after about thirty-six hours as a stock for a brewing of fresh yeast. This barm may be used for sponges, but the general practice is to make straight doughs standing in trough for about eight hours. For the first two or three hours after dough is made it seems

Making Fresh Stock.

[1] From work published 1830. Author's name not known.

quite clay-like and dead, but it afterwards ferments with vigour, and the ultimate loaf is of full volume and good flavour. The dough is the better for a good kneading before being thrown out to scale.

Mode of using "Spon".

The manipulation of the loaves does not materially differ from the methods followed when other kinds of barm are used. For one sack of flour about $1\frac{1}{4}$ gal. of this barm is required. Here, as in the flour barms, there is a good deal of scalded starch—from potatoes in this case—which is ultimately changed into sugar. The diastasic agent here, however, is not malt, but probably the cerealin cells of the bran used. The large quantity of sugar supplies an abundance of that material for the yeast to ferment, while the flour, potatoes, and bran supply enough proteids and mineral matter for abundant yeast growth. The purpose of cooking the flour used is not very obvious. If sufficiently cooked, some of it may be changed into dextrin; otherwise, the flour will be less ready to form into small lumps than if it were added raw. It is interesting to note that while about thirty-six hours is a sufficient time for barm of this sort to mature spontaneously ready for use, the same sort of liquid will not have reached the state of maturity in the ordinary conditions prevailing in this country in less than forty-eight to fifty hours. The only explanation is that the air of subtropical countries contains a larger quantity of germs (probably spores) suitable for the inoculation of a wort of this sort than ours, which germs would also of course be in greater abundance on the added bran.

Cooking Flour.

Germ-laden Atmosphere.

In Malta, and many parts of Spain and Portugal, a kind of batter or barm is used which is made as follows. 4 oz. best hops are boiled with 3 gal. water for about twenty minutes. When the water is still boiling, it is poured, after the hop leaves are strained from it, on to $12\frac{1}{2}$ lb. strong patent flour placed in a tub, and stirred vigorously with a stick until it forms a firm batter or dough. This is then turned out on to a clean board or slab. When cold, 2 lb. of batter from a previous making is thoroughly mixed in the mass, or 4 oz. of pressed yeast may be used the first time. The stock is rubbed in till the paste is quite smooth, and it is then filled into a jar, cleaned and scalded, which is kept for the purpose. This paste is kept at a moderate temperature—from 76° to 78° F.—for about thirty-six hours, and at the end of that period it is kept in a cooler place for future use. It will keep good for a week in cool weather, and for three or four days in summer. For a 280-lb. sack of flour 3 lb. of batter yeast is required with a sponge-and-dough system, occupying until the dough is ready for scaling about fourteen hours. This kind of barm differs little from flour barm of the Virgin kind, except in its thickness; it is simply a variety of leaven. There is, especially in very hot weather, a good deal of trouble in handling this kind of barm to obtain sweet bread; it has a tendency to become sour very readily.

Maltese and Spanish Barm or Leaven.

The following is a very strong barm, with much better keeping qualities than the ordinary. 6 lb. of malt flour or meal and 6 lb. of rye flour are

mixed together and made into a soft dough with 2 gal. of water at 120° F.

Barm of Malt, Rye, and Flour.

This dough is then scalded with 4 gal. of boiling water. This thick paste is allowed to lie for about eighteen hours, gradually cooling. Four gallons more boiling water is then added, and well stirred in. This addition should raise the temperature to 160° F. Twelve pounds of crushed malt is mixed in it, and the mixture allowed to stand an hour, when another 3 gal. boiling water is added. The purpose of this last addition is simply to maintain the temperature between 150° and 160°. This water will raise it to 154°. It is then allowed to stand for seven hours. Before the seven hours expire, boil 3 oz. of hops in 3 gal. of water for about thirty minutes. Add this, when strained at the end of seven hours, to the wort already prepared. The whole is then strained and cooled to about 90° F. in winter. Two gallons of stock from a previous making is added, and at the same time 2 lb. more rye flour in the raw state. The barm will be ready for use in about forty-eight hours from the time it was started. It may be used for a straight dough to lie in trough about ten hours, 1 gal. of barm being used; or it is suitable for half or quarter sponge in the usual way. If the former is to stand eleven hours, 3 quarts of barm will suffice; about the same amount is used for a quarter-sponge to stand the same time, only sponged a few degrees colder.

This barm is really a mixture of compound barm and Parisian. The addition of rye instead of wheat flour really increases the quantity of pro-

Enzymes in Rye.

teid matter possessing enzymic properties, for rye has to a slight degree the power of changing gelatinized starch to sugar, and to an even greater degree a peptonizing effect on proteids. The addition of hops to the worts, after the latter have been lying for some time, is to prevent the formation of bacteria. The malt used supplies an ideal medium for the growth, and rye is only slightly inferior to malt for the same purpose. When stock is added, 8 oz. of salt may be stirred in at the same time, the purpose being to steady fermentation further and prevent exhaustion. The recipe and method for this barm were given to the writer by Mr. D. M'Peak, of Ballymoney, Ireland, who had used it successfully for a long time; and the writer tested some samples of the barm three weeks old, and found it still sweet and healthy and capable of vigorous fermentation of dough.

The following is the old method of making barm with a mixture of malt, rye, and potatoes. Boil 3 oz. of hops with 5 gal. of soft water till

Old Method: Malt, Rye, Potatoes.

the hops sink, then cool it to 170° F., and stir in 4 lb. of ground malt and 4 lb. of rye flour. Let this "mash" for three hours; then press the grains from the liquor through a fine sieve. Have ready 4 lb. of sound potatoes, washed and steamed, or boiled. Break these up, skins and all, and pour the malt-rye liquor amongst them, and stir well. When properly mixed, the wort should be strained from the potato skins. When cooled to 78°, add 2 quarts of the same yeast from a previous making, or other stock like brewers' yeast, and

at the same time 3 oz. of salt. Let this ferment in the usual way until the top of the liquor becomes clear, when it is ready for use. This makes strong barm, and about 2 quarts is sufficient for a sack (280 lb.) of flour, if made on the half- or the quarter-sponge system.

Theory of Barm-making.

Action of Enzymes.

Danger in overheating Malt.

The different materials and methods used in making barms and yeasts are really only varying means of obtaining food and stimulant for yeast growth. If scalded starch is used, either from wheat flour, or rye, or barley, or potatoes, there is always an enzyme also provided, for the purpose of changing that starch—which is not itself fermentable—into a form of sugar which is fermentable, such as maltose or glucose. These enzymes are present in malt, in rye, in the cerealin coats of bran, in the soluble proteids of white flour, in wheat germs, and even in yeast itself. The purpose, therefore, of adding quantities of these respective substances to the barm mash is quite obvious; they are converting substances, for preparing the worts for effective yeast nutrition, as well as, of course, supplying the material to be converted. In the case of yeast itself it supplies the living matter. Malt in some form or other is the usual enzymic agent—diastase; and as this is coagulable at about 170° F., and is therefore ineffective for its work if kept for long at that temperature, hence the instructions in all cases to cool to that temperature before adding the malt. There is an apparent exception in the case of flour barm containing malt, as that is treated with boiling water after being mixed with flour; but, as already explained, damage is prevented by the comparatively cold dough cooling the boiling water, while mixing, down to about 170° F. The sole object in making liquid barms is to grow a large crop of yeast from a small quantity of seed, and this object is best attained by supplying a medium rich in proteid matter and in sugar, or at least in some substance capable of being changed into sugar.

Barm- and Yeast-making Compared.

It has been already pointed out that yeast-manufacturers, besides supplying a medium highly nutritious for yeast, also impregnate the liquid with free oxygen, while the proportion of sugar material is reduced. This is found to be the ideal condition for the maximum yield of yeast, while the minimum quantity of sugar is broken down and a smaller proportion of alcohol produced. The process in barm-making analogous to this aeration is when barm is stirred at intervals, or, as in the manufacture of Parisian, when the barm is poured several times from one tub to another.

Action of Enzymes increased with Temperature.

The interval allowed when malt is being mashed in water, before the grains are strained from the liquid, is to secure as much as possible of the soluble extract, while the injunction to maintain the mash at a high temperature while it is standing is to allow for the conversion, by the action of the diastase of the malt, of as much as possible of the starchy part of the grain which had not already been converted into sugar during the process of malting. Diastase, like other enzymes, performs its functions at a rate

varying with the temperature, in the same way as yeast does, only the temperature at which the maximum result is obtained from diastase (about 150° F.) is much beyond the limit at which the organized yeast cell is even able to live (about 130° F.).

General Features of Barm-making.

In every case of barm-making there are several common features. The saccharine matter is supplied in the form partly of sugar and partly of starch which had been previously gelatinized, and there is an enzyme in one form or another used to convert this starch to sugar. In malt the unconverted starch grains have already their skins burst through the action of an enzyme called *cytase*, which possesses a solvent action on the cellulose skins of starch, but seems to be active only while the grain is growing. Then the diastase in the mash completes the starch conversion into sugar. In Parisian barm the scalding operation gelatinizes the starch of the flour; then the malt present converts it into fermentable sugar and dextrin. In Virgin the starch is again gelatinized as a preliminary operation; but here the only enzyme present is the soluble proteid of flour, and it is to supply this that raw flour is added when the "scald" is cold. In cases where a quantity of stock is also added, the yeast that the stock contains will, of course, be a factor in assisting the change of some at least of the starch into sugar. But in this particular type of barm the acids which are invariably formed may convert the gelatinized starch into soluble starch, and a good deal of this probably remains as soluble starch only, while yeast growth takes place on the strength of the natural sugar of flour, the part of the gelatinized starch actually converted, and the proteid matter of the flour, which is also changed to peptone by the action of acid or by another enzyme in the barm. Changes like these would account for the comparative weakness of this type of barm and the necessity for using a larger quantity, and they would also explain the mildness with which it works in dough, the soft clay-like feel the dough has when moulding, and the characteristic soft bread it produces.

Why Barms are weak.

In the case of the so-called spontaneous yeast described, the steamed or boiled potatoes supply gelatinized starch, the flour supplies the principal part of the proteids, while the cerealin of bran contains the enzyme which may convert the potato starch into sugar and dextrin. But in this barm the added sugar is amply sufficient to supply all the sugar required by the yeast, even if none of the potato starch is changed past the condition of soluble starch.

Use of Hops.

In all the malt-flour and potato-barm recipes given except one a small quantity of hops is given as one of the essential ingredients. The purpose is to prevent the too active growth of acid-producing germs without seriously hindering the action of the yeast, but it is doubtful if hops are nearly so effective to this end as some suppose. Hop liquor does retard the fermentative activity of yeast even in a sugar solution, but it can hardly be added to barm for this purpose, and the grounds on which it is said to be specially deterrent to the action of bacteria and

germs other than yeast, while giving, as it were, a free pass to the latter, do not seem well established. The probability is that their use in barm on the part of bakers is a concession to custom as established by brewers, from whom the method of barm-making was first obtained as a modification of the beer-making process. The brewer does not, however, use hops for the same purpose as the baker. He uses them partly for flavour, and partly in order that their tannin may have an astringent effect on the proteid matter in the wort from which the beer is made, and so make it easier to clear and brighten. In any case, however, hops, like salt, do produce a steadying action on yeast fermentation, even if they do not prevent the action at the same time of acid-producing bacteria, although it is likely that they have the same slowing action on these germs as on yeast. So far as hops retard the action of yeast, this is probably in part due to the astringent effect of their tannin on the yeast food in the medium in which it is growing, whether this is a malt wort or a mixture of flour and water, whilst the bactericidal properties of hops are probably due to the essential oil which they contain in considerable quantity. It is this oil that produces the pleasant odour from hops. The intensity of the odour serves in its turn as an indication of the value of the hops. A few pods are gently rubbed between the palms of the hands; then the hops are removed, and the odour from the hands ascertained by making a cavity between them, and placing the nose at the opening.

Acid-producing Bacteria in Barms.

The presence of acid-producing bacteria is a normal condition in all barms, and the idea that, for bread-making purposes at least, it is desirable to eliminate those entirely is now discarded. There is no doubt whatever that the acid-producing germs and the acid which they produce perform important functions in the subsequent processes of bread-making, but while this is so, these germs and that acid must bear only a small proportion to the yeast present, and it is found that even with the greatest care in barm-making there are enough acid-producing germs in the mixture, while carelessness increases the proportion, so that it becomes excessive, with very bad results. The most fruitful cause of this excess is probably the use of badly cleaned utensils. Oak tubs are the best kind of vessels to use for storing the barm. These should be very thoroughly scalded every time they are emptied, as well as when about to be filled with new barm. If the tubs have to stand empty for some time, they should be exposed to fresh air, which has the effect of thoroughly sweetening them, as some kinds of bacteria are destroyed by this means. When the tubs seem to be saturated with acid they should be well coated inside and out with lime wash, or if that is not easily secured, then with a strong salt brine. In either case, if this is done, the tubs should be scrubbed with cold water to remove the salt or the lime, then thoroughly scalded before use. It goes without saying that to ensure regularity in the strength and quality of the barm, whatever its kind, the thermometer should always be used, and while correct weights of materials should be made, it is as well also to take the specific gravity of the worts by an

hydrometer, as all malts do not give equal densities for equal weights, and it is the density of the wort that really matters.

Why Barm is used in Australia.

It may seem almost superfluous to devote so much space to the consideration of home-made barms; but, apart from the knowledge to be obtained by the details of manufacture and the distinctive properties of the different ingredients, there is still a wide field in which it is of the greatest practical importance to be able to make barm successfully. Bakers on ships require this skill; in all tropical and subtropical countries these barms are still in regular use; and in most of these cases this condition is likely to remain unless some discovery is made which will ensure yeast keeping in very hot weather and being transported by rail for long distances. The continent of Australia, for instance, is still too sparsely populated to make it possible for yeast to be manufactured on a large scale for distribution over the whole continent from one centre, and the trade of any one populous centre would hardly be sufficient to keep even a small factory going. The same thing is true of India, Africa, and Central Asia. Moreover, the use of home-made barms is still predominant in Scotland, and in a few cases in the north of Ireland. In some parts of rural England, where there are no convenient railway facilities, barm of the compound or patent sort is still in use. There is a certain completeness about the skill of the baker, which involves the whole operation from the beginning of barm-making to the baking of the loaf, that makes his work an all-absorbing, almost a religious obligation, and it has an effect on the character which makes the baker practically a slave to his calling. This was even more apparent in the old days, when a baker hardly ever occupied himself in any public or personal work outside his own business as a baker.

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